AERONAUTICAL ENGINEERING REVIEW

MAY 1943

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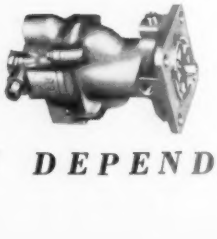

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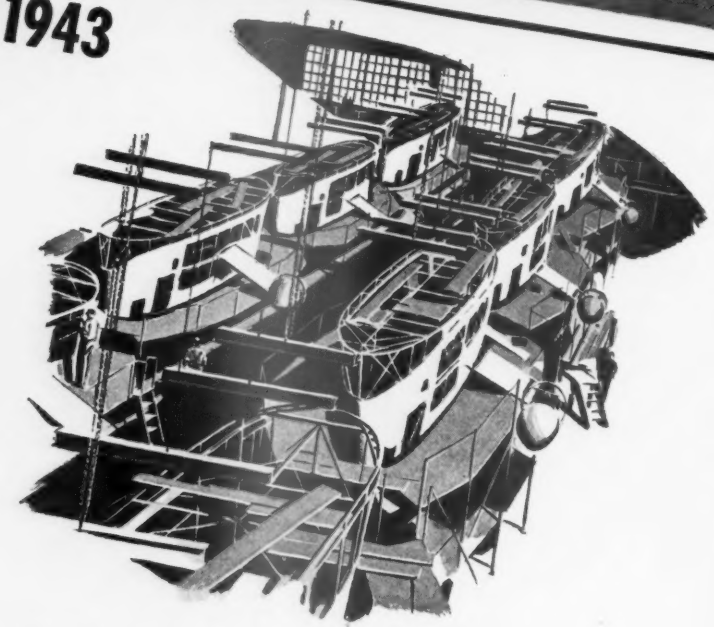
1943



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Thin Case Hardening with Radio-Frequency Energy

VERNON W. SHERMAN*

Federal Telephone and Radio Corporation

SUMMARY

Distortionless thin case hardening with radio-frequency energy makes possible the finishing of parts to final dimensions prior to heat-treat. Uniformly hardened cases 0.005 to 0.030 in. deep, controllable to within ±0.001 in., have been produced using 5 megacycle energy. Photographs of applications show the heat-treating process as applied to the outside diameter of cylindrical surfaces, the inside diameter of tapped bolt holes, and the flat edge of a slide plate. For most heating processes the 5–15 megacycle range of frequency is recommended by the author. It is shown that in order to produce thin hardened cases two fundamental energy requirements exist: (1) The frequency should be in the megacycle range so that the induced energy is confined to a thin surface layer; (2) power must be applied to the surface of the work at not less than double the rate of heat conduction loss from the surface to the core.

Macro- and microphotographs show that the thin cases produced with megacycle energy are homogeneous and uniform. The transition from case to core takes place smoothly and in a short distance compared to the case thickness. Because of the speed with which the surface layer is heat-treated, no measurable tempering action was found to have occurred in the adjacent core layer. The case was found to be under compression, but because of its relative thinness the total force was negligible. A mathematical expression is given which has been found to express the temperature after a time t of a point located a distance x beneath a heated surface. The expression involves constants that may require reinterpretation if the geometry of the part is appreciably changed. By use of the expression a set of curves is developed showing a temperature distribution that is in good agreement with experimental evidence.

PREFACE

THE DISCUSSION of thin case hardening with radio frequency falls logically into two major divisions and the subject is accordingly divided into: (1) the consideration of energy requirements, temperature distribution, and metallurgical results; (2) the consideration of factors controlling the distribution of electrical energy in the surface of steel being heated by radio frequency current.

The present paper (1) is concerned with induction heat-treating in the 1–20 megacycle frequency range. It is further restricted by the proposition that an induction heating process should be able to establish a thin case of hardened metal on the surface of a hardenable steel without distortion of the part, scaling of the surface, or disturbance of any prior heat-treat already established in the core. By a thin case is meant one between 0.005 and 0.030 in. This case thickness should be controllable to within ±0.001 in. and should be capable of reliable duplication in quantity production. The author will attempt to show that the time required for establishing the case should not exceed 1.0 sec. Examples will be given wherein thin cases were produced in times ranging between 0.6 and 1.0 sec. For this class of heat-treatment a frequency above 1 megacycle and available power output of 25–75 kw. was commonly required.

Presented at the Materials Session, Eleventh Annual Meeting, I.Ae.S., New York, January 25–29, 1943.

* Manager, Industrial Electronics Division.

BACKGROUND

Induction heating of metals is not new. The earliest electrical experiments indicated the possibilities. Before the turn of the century a good many patents concerned with this field had been issued both here and abroad. In 1890, Colby was issued a U.S. patent for an induction melting process. His application was filed in 1887. Colby showed a rotating generator as a source of alternating or pulsating electrical energy, a current transformer with a core of soft iron wires electrically insulated from each other, and a low impedance single turn secondary in the form of an annular trough to hold the melt. He also pointed out that in the case of conducting metals the furnace melt or charge could constitute the entire secondary circuit. Nikola Tesla, writing in the *Electrical Engineer*, 1898, describes in some detail an early use of Hertzian Waves for induction heating. This work was of an experimental and pseudomedical nature, but regardless of its practicability it makes fascinating reading. Tesla used a spark coil oscillator. In 1925 a U.S. patent showing vacuum tubes as a source of energy for induction heating apparatus was issued.

INDUCTION HEAT FREQUENCY

Just as frequency converters for radio communication purposes have gone through an evolution from rotating machinery, to spark gaps, to high-power vacuum tubes, so we can trace a similar pattern, but in a much briefer time, for the induction heat-treatment of metals. The power vacuum tube has earned its place in the field largely through years of painstaking and thorough development which has made it the key piece in modern broadcasting.

All of the frequency converters mentioned are reliable. There is, however, a range of frequency best suited to each converter, and this fact leads naturally to a grouping of induction heat equipment according to the frequency used. Fig. 1 gives a logical grouping and indicates the particular frequencies most commonly used in each group.

To summarize the chart of Fig. 1, the principal frequencies in use at the present time for commercial melting, preheating, and annealing are, in general below 12,000 cycles. For surface hardening of relatively large parts where considerable depth of case can be permitted, even frequencies near 12,000 are of value. For thin case hardening (0.005–0.030 in.) frequencies above 500,000 cycles are indicated. For most heating applications the author recommends 5,000,000–15,000,000 cycle energy, and even special requirements seldom lie outside 1,000,000–20,000,000 cycle energy.

Versatility

The versatility of induction heating equipment increases cumulatively with the frequency used. For example, 5 megacycle energy can, in addition to melting, annealing, etc., also produce thin surface hardening without disturbing a prior heat-treat of the core. The same 5 megacycle energy can also be used for drying paper, bonding plywood, softening thermoplastics, and many other operations in the dielectric heating field.

Resinox treads are quickly and easily assembled to hub and two steel halves of wheels.

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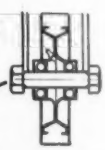

Treads must be accurately molded so flanges of two stamped steel wheel halves will fit snugly, holding treads securely.

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FIG. 1. Induction Heat Frequency Spectrum—Use and Power.

60* 180* 360* 1,000	2,000* 9,600* 12,000	50,000 200,000	450,000* 5,000,000* 15,000,000* 100,000,000
Preheating, annealing, or melting of magnetic material by direct induction and of nonmagnetic material indirectly.	Melting, brazing, and general heat-treat—deep and approximate surface treatment with 9,600.	Melting, brazing, and general heat-treat—limited surface treatment dependent upon power and frequency.	Controlled depth surface heat-treat. Vacuum melting. Accurate zone heating for hardening, brazing, or silver soldering. Sustained heating beyond magnetic critical. General heat-treat of both magnetic and nonmagnetic materials.
			Electrostatic heating as in bonding of plywood, thermosetting of plastics, dehydration processes, etc.
Rotating alternator up to thousands of kw.	Rotating alternator up to 1,200 kw.	Spark gap oscillator up to 35 kw	Vacuum tube oscillator up to 600 kw.

* Frequencies most generally used.

Cost of Energy

The energy cost of induction heat at a frequency other than commercial 60 cycle carries a cost penalty. The penalty is due to the frequency conversion means and not to the frequency itself. It is important to note that the efficiency of frequency conversion with vacuum tubes can be as high or higher than that of lower frequency means. Depending upon the efficiency of the equipment, heating energy may cost from 3 to 6 cents per kilowatt hour as compared to a 60-cycle base cost of 2 cents.

GENERAL CONSIDERATIONS

In the field of heat-treating a desirable result has long been the creation of a hard skin over a tough interior. Fig. 2 shows two conflicting curves that picture rather well the dilemma in which the metallurgist frequently finds himself when he is faced by the simultaneous requirements of hardness and toughness from the same heat-treat. Fig. 2 shows that a steel quench-hardened throughout to 60 Rockwell C may have to be drawn back to 35 Rockwell C before its toughness is satisfactory. The author will attempt to bring out in this paper what is considered to be an ideal solution to the problem and one that will allow the metallurgist to "have his cake and eat it too." The problem is that of retaining a desired internal toughness at the same time a surface hardness is created.

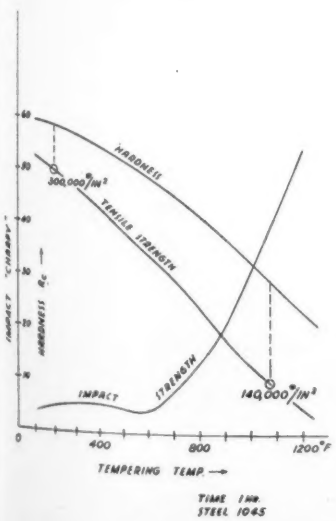

FIG. 2.

In general, "surface heat-treatment" has had two practical faults: (1) The heat has penetrated too deeply and (2) the penetration was frequently far from uniform. These have commonly been due to either too low a frequency or a slow heating rate which made it necessary to maintain treatment for a considerable period of time, such as 15 sec. or more.

With a surface temperature of 1,600°F., the loss of surface heat by natural conduction to a 75°F. layer 1/4 in. beneath the surface is at the rate of approximately 5 kw. per sq.in. of surface, as shown by Fig. 4. The transfer of surface heat to the interior is a function of time and of temperature difference between the surface and the interior. It decreases only as the interior becomes hotter, and it therefore follows that if heating of an interior layer by the surface temperature is to be prevented, the heating power must be equivalent to several times the conduction loss and the time of treatment must be kept short enough to drastically minimize conduction. Heat conduction is the number one obstacle to uniform case hardening. Heat is generated in a controllable depth of case, but the heat flow to the interior will be determined by the configuration and thermal properties of the part and may well be out of our control. Since there is usually no excuse for hardening to a depth much in excess of allowable future wear, it seems that the cost of heat-treat energy and time is only justified in a layer some 0.010 to 0.030 in. deep. In applications where impact load or high unit stress is the criterion, somewhat thicker cases may be required.

Solution of Carbides

The time required for carbides to go into solution seems to be extremely short. It has been experimentally true in laboratory work that whether the steel were a plain carbon type or an alloy steel no difficulty was encountered in putting the carbides into solution and securing just as hard a case in a fraction of a second as could be had with longer treatment by standard furnace procedure. It appears that the rate of heating of the steel is independent of its chemical composition, except insofar as that composition may affect electrical or magnetic properties. It is possible that with induction heating the higher resistance of undissolved carbides actually results in abnormally high temperatures in and near such carbide inclusions which promotes especially rapid solutions of the carbides.

Hardenability

The hardenability of the steel under the high-speed radio-frequency process appears to obey the relations to chemical composition as set forth in M. A. Grossman's excellent treatise on the subject.

Distortion and Scaling

In certain hardening work the prime objective may not be surface hardening as such. It is often important for economic reasons to prevent distortion and scaling of the part so as to eliminate

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*THE SHOCK ABSORBING UNITS ON AN AIRPLANE'S LANDING GEAR; THE NAME IS DERIVED FROM THE WORDS "AIR" AND "OIL"—THE FLUIDS USED TO DISSIPATE THE LANDING SHOCKS

or to drastically minimize grinding costs. The essence of this problem lies in producing a uniform thin case so that the interior metal will still retain ample strength to hold its original shape. Freedom from scaling or severe oxidation can be secured through reduction of time just as readily as it can through reduction of temperature. When the heat-treatment is completed in a second or less, there is no scaling of the surface, even in ordinary atmosphere. This time is barely sufficient to create a blue oxide color. It is, of course, thoroughly practical when using radio-frequency energy to conduct the heat-treating in a controlled atmosphere, such as hydrogen and thus prevent oxidation.

Subnormal Strength Layer

There is a possible consequence of surface heat-treating which is of considerable interest. This is the danger of creating just beneath the hardened layer a second layer of subnormal strength. Consider as an example a steel axle shaft that has, for purposes of best physical properties, been heat-treated throughout to a hardness of 33 Rockwell C. To satisfy a bearing application, next surface-harden a deep layer, perhaps $^1/_8$ in., over a portion of the shaft's surface. If in so doing the temperature of this $^1/_8$ in. surface layer is raised to 1,700°F. and held there for 30 sec., it is obvious that a second layer in direct contact with the surface layer may experience tempering. The thickness of this tempered layer will depend upon the temperature and the time of drawing. Once this time has elapsed a helpless position results, since not only has considerable heat been stored within the body of the part which will retard the quenching of the surface but this same stored heat promotes further tempering of the second layer. If the second layer loses hardness by tempering, it will, in general, also suffer a loss of tensile strength, as indicated by the curves of Fig. 2.

Control of Tempering

The amount of tempering is a function of time and temperature. Temperature has been fixed by the requirements of the job. Fig. 3 shows that most of the softening action occurs in the first few increments of time and that for a given temperature the tempering action decreases logarithmically with time. Thus, the loss of hardness for a 10-sec. time interval between 10 and 20 sec. would be substantially the same as the loss during a 100-sec. time interval between 100 and 200 sec. of total tempering time. The curves shown are for a particular carbon steel only. Fig. 3 teaches that if tempering is to be prevented, action must be taken during the first few seconds.

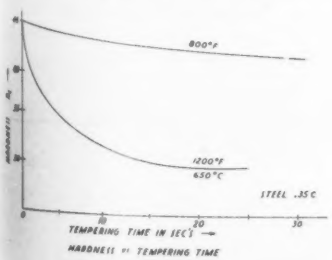

FIG. 3.

ELECTRICAL ENERGY REQUIREMENTS

When an iron cylinder is placed within the turns of an induction heating coil energized with alternating current, heat is developed in the iron part. It has already been noted in a general way that a high rate of energy input for a short time interval is required to restrict heating to a controllable surface layer. The relationship between rate of heating and the electrical energy required to produce it will next be considered.

Process of Heat Generation

When the turns of the induction heating coil enclose an iron cylinder, a transformer is created whose secondary is the short-circuited surface layer of the iron cylinder. The current I which is induced into this secondary flows through a resistance R and develops heat at a rate that in watts is equal to I^2R. This is the mechanism whereby electrical energy is converted into heat energy.

In a particular induction heating coil there will be a finite number of turns, such as ten, and through these turns the equipment will drive some definite current, such as 100 amp. There is then available for heat-treating purposes a 1,000 amp.-turn primary. Since the secondary consists of one turn, its theoretic maximum current cannot exceed 1,000 amp.

Coupling Factor

Because of the need for insulation, mechanical clearance, etc., the secondary will be spaced somewhat away from the primary and therefore not all of the primary flux will thread the surface of the work. If only 50 per cent of the primary flux links with the surface of the work, then the coupling factor is 0.5 and only half the primary ampere-turns, or some 500 amp. in the one turn secondary circuit, are available for generating heat in the work. Since the heating rate in watts equals I^2R and since the current has already been determined by the primary ampere-turns and the coupling factor, it follows that the rate of heating in the metal can only be increased by increasing the resistance of the surface layer in which the current is confined.

Resistance Versus Frequency

It will be shown in a later paper that the thickness of the layer in which the current is confined varies inversely as the square root of the alternating current frequency. Accordingly, if the operating frequency is increased from 1 megacycle to 4 megacycles, the thickness of the current-carrying surface layer is reduced to one-half. Therefore, the secondary resistance through which the 500 amp. must flow is doubled, and the heat developed in the surface layer by this current is also doubled. At the same time, the heating current has been restricted to half of the depth it occupied at the lower frequency. The problem of keeping the resistance high by means of a thin surface layer is of increased importance as the diameter of the work becomes smaller. For example, if the work were $^1/_4$ in. outside diameter as compared with 1 in. outside diameter, the resistance of the current-carrying path would be only 25 per cent of that of the larger piece.

The above example brings out a fundamental reason for high frequency in surface hardening. There will always be a frequency converter of limited output; an induction heating coil with a limited current-carrying capacity; a finite number of turns; and, last, a coefficient of coupling between the work and the coil whose value for practical design purposes is also fixed. All the above restrictions will limit the magnitude of the secondary current. There remains only the control of the secondary resistance by exploitation of high-frequency skin effect.

Loss from Heated Metals

The rate of loss of energy from a heated metal surface, both to air and to a 75° internal layer, is plotted in Fig. 4. Two representative metals, iron and

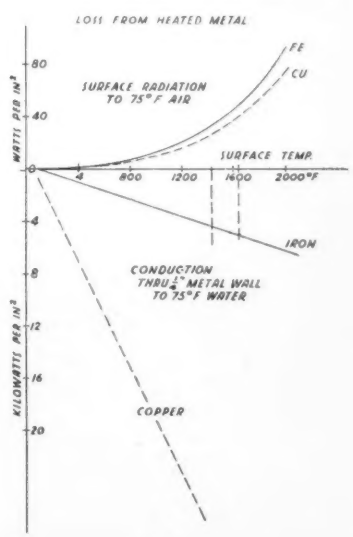

FIG. 4.

More data on Du Pont "Lucite" methyl methacrylate resin sheets for aircraft designers, engineers and their established transparent enclosure suppliers.

HOW DO TEMPERATURE AND HUMIDITY AFFECT FLEXURAL STRENGTH OF DU PONT "LUCITE"?

THE FLEXURAL STRENGTH of cast "Lucite" sheets, at 77°F. and 50% relative humidity, ranges from 14,000 to 16,000 pounds per square inch. (See Fig. 1 for method of measurement.) Allowance should be made in designing aircraft enclosures using the plastic, however, for the effects of temperature and humidity extremes on its flexural strength at high altitudes and in some climates.

FIG. 1

MEASURING FLEXURAL STRENGTH OF "LUCITE"
Test method: A.S.T.M. procedure D650-41T. Test bar is loaded at midpoint while supported at each end, and strained at uniform rate using a standard testing machine. Deflection of bar is recorded, and flexural strength (fiber stress at the load causing failure) is found using the formula: $S = 3PL/2wt^2$ where P is breaking load, L the distance between supports w the bar's width and t its thickness.

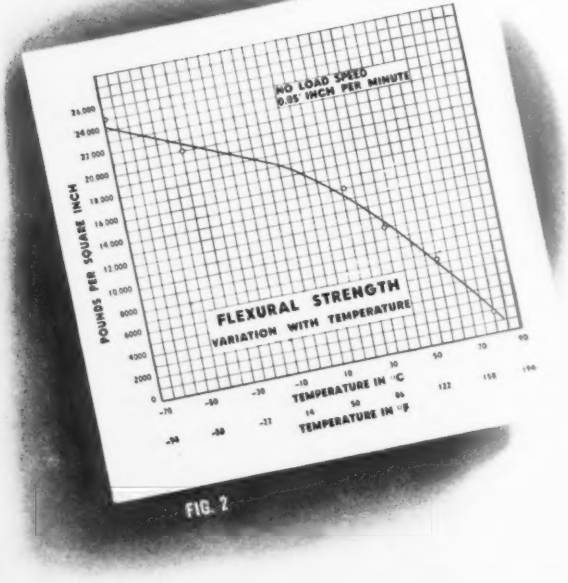

FIG. 2

TEMPERATURE The flexural strength of "Lucite" decreases with rise in temperature (See Graph, Fig. 2). Therefore, designs requiring high fiber stress should be avoided.

FATIGUE The flexural strength of "Lucite" sheets decreases under *continuous load* (Fig. 2). Long-time flexure tests indicate that beams should be so designed that maximum fiber stress, up to 77°F, is not more than 1,000 p.s.i. From 77° to 100°F, a maximum stress of 650 p.s.i. is recommended. Higher fiber stresses may lead to failure under unusual temperature rise, and loss of optical properties due to "crazing" of surface.

MOISTURE "Lucite" becomes saturated after slight water absorption. Thus, even after soaking in water for 96 hours, its flexural strength remains almost unchanged. At temperatures of −40° and −112°, such water-soaked samples even show slight increase in flexural strength.

CONTOUR OF FINISHED ARTICLE Since the outermost fibers are the most highly stressed in flexural loadings on "Lucite", sharp surface irregularities greatly increase localized stresses and lead to failure at these points. Therefore, surfaces should be finished smooth, and all angles should have well-made fillets of large radii.

SEE THIS MANUAL FOR MORE DATA

Physical influences affecting the flexural strength of "Lucite" make it important that enclosures of the plastic be mounted and installed properly. The 114-page aircraft Manual on "Lucite" gives detailed information on this subject . . . also on fabricating, forming, repairing and general properties of "Lucite". Get your *free* copy. Write on your business letterhead to: E. I. du Pont de Nemours & Company, Plastics Department-R, Arlington, N. J., or 5801 So. Broadway, Los Angeles.

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METHYL METHACRYLATE RESIN

copper, are considered. The curve shows, for example, that the rate of energy loss from a 1,300°F. surface of iron to an internal 75°F. layer that is located 1/4 in. below the surface will be some 4,000 watts per sq. in. It is also seen that while 4,000 watts of energy leaves the surface by conduction to the interior only 25 watts of energy are being lost by radiation to outside air. It thus appears that for all practical purposes the radiation loss is negligible as compared to the conduction loss. The curves of Fig. 4 bring out a second fundamental heating requirement—namely, that in surface hardening the conduction loss at the temperature in which there is interest sets a minimum heating rate requirement in kilowatts per square inch. Unless electrical energy can be supplied from the induction heating unit at a rate at least double that of the conduction loss, it is not reasonable to expect much better than nonuniform deep heating of the work which would upset any previous heat-treat of the core.

Watts per Square Inch—Example

Just how much electrical energy per square inch must be supplied beyond that dictated by the conduction loss depends upon the temperature that can be tolerated at particular depths beneath the surface. It has been found that by applying electrical energy at a high rate, a 0.007-in. layer can be hardened to 60 Rockwell C without effecting a prior heat-treat of the parent metal. To accomplish this required three times more energy per square inch of surface than the conduction loss. It also required a frequency near 5 megacycles and a time of 0.6 sec. The relation between time of heat-treat and hardened case thickness for a fixed power output is plotted in Fig. 5.

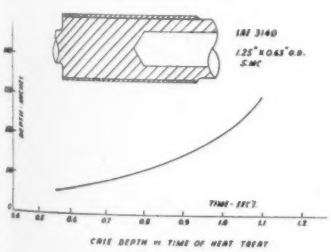

FIG. 5.

Cost of Energy—Example

Analysis of the associated operating data shows that when the heating energy is restricted to the vital layer operating costs are drastically reduced. As an example, consider in Fig. 5 the 0.020-in. case, which required 1.0 sec. of heat-treat. The surface area was 2.25 sq.in. The full-load line power was 63.6 kva. The no-load line power was 15.6 kva. With an assumed load cycle of 50 per cent (i.e., 1 sec. "on" and 1 sec. "off") and an electrical energy cost $0.02 per kwh., it is noted that the unit has a capacity of 1,800 pieces, or 4,500 sq. in. per hour, and that 23 pieces have been case hardened or some 52 sq. in. of surface for each cent's worth of electrical energy. It is important at this point to note that if it had been required to heat the entire piece operating costs would have been increased some 500 per cent.

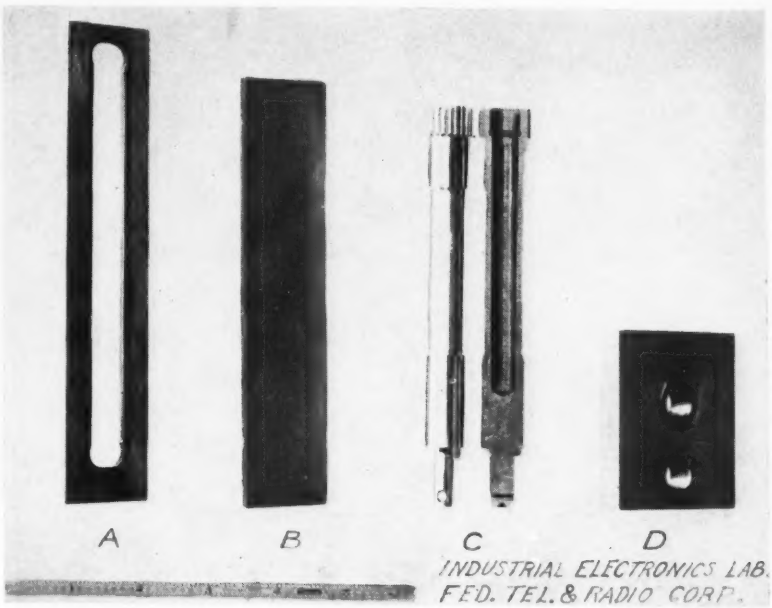

FIG. 6.

METALLURGIC RESULTS

The author feels that before the metallurgic aspects of thin case hardening with radio frequency can be intelligently discussed it will be necessary to analyze test findings in a broad and diversified field of applications. The reaction thus far obtained from competent metallurgists has been that in many respects the structure is difficult of analysis and that the appearance of the microphotographs should not be interpreted entirely in the light of microphotographs resulting from slower speed methods of heat-treating. The author will therefore confine his remarks largely to the presentation of photographs and test data.

Examples

Some of the hardening operations possible with radio-frequency energy are represented in Fig. 6. Part A is a slotted guide plate shown as an example of surface hardening of straight flat surfaces. The plate is 1/8 in. thick and has two parallel guide faces 5 1/2 in. long separated by a distance of 1/2 in. The parent metal had a hardness of 20 Rockwell C and the surface hardness of 55 Rockwell C was created in 0.9 sec. The surface was self-quenched. No external coolant was used. Part B is a strip of 1/8-in. steel that has had one edge only hardened. This is similar to part A but shows the additional fact that it is not essential for the work surface to form a closed loop. Part C is a certain shaft upon which two bearing journals were to be surface hardened. This shaft example was the most difficult of those shown, due to the fact that it has a nonuniform interior cross section. Because the wall thickness in the hollow portion is only 1/8 in., this shaft was selected for the paper as a good test example of thin case hardening with radio frequency. Part D is a 3/8 in. inside diameter tapped hole and illustrates that inside surfaces of small areas can be heat-treated with radio frequency energy at speeds sufficiently high to permit self-quenching of the surface.

Macrophotographs

Fig. 7 shows a longitudinal cross section of the shaft after its bearing surfaces were hardened with radio-frequency energy. It will be noted that the shaft had been drilled out prior to heat-treat so that a portion of the lower bearing has a wall only 1/8 in. thick, as at section A, whereas at section B the shaft is solid. Macrophotographs of cross sections taken at position A and position B from a similar shaft are shown. It will be observed that in spite of the difference in depth of parent metal beneath the surface to

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Every minute tonight, some squadron of young U. S. pilots will lift their wings from a darkened field. They're starting out with grim confidence.

It will help them if we at home get clear on where the stupendous U. S. air program now stands—and on the place where each of us can fit into that plan and help make it go forward faster.

As aircraft designers and engineers, the "Northrop group" is working night and day under that plan. Northrop submits here some facts on what's going on.

• • •

What kind of planes is the U. S. building? This is a new kind of air war. In it the old-style "all-purpose" fighting plane isn't good enough. Today, one new plane may be a champ at what are called "low altitudes". But *because* it's so good close to the ground it isn't good enough 5 miles up in the sky.

The way to be best near the ground, and up high, and every place in between, is to have many different kinds of pursuit planes. That's what America is creating day and night—ALL kinds—including improvements on fighters already battle famous and deadly new ones you've not yet heard about. And plenty of each kind.

It's the same with bombers. In some areas we need bombers that will carry "block-busters" thousands of miles and come back home safe. In other areas another kind is better—bombers that will carry still bigger loads but have less flying range.

So here again the answer is many kinds of bombers. That is what the U. S. A. is building—and at a speed no nation ever dreamed of before.

• • •

What can a person do to help? *Every rivet in an airplane costs about 3 cents to drive into place. There are 600,000 rivets in one four-motored bomber. So, when you buy an $18.75 war bond you drive 625 rivets. Maybe that's enough rivets to hold a wing in place after a Jap shell has torn it, enough to get some boys safe back to their field after a night in a war-torn sky.*

NORTHROP AIRCRAFT, Inc.

NORTHROP FIELD, HAWTHORNE, CALIFORNIA • MEMBER AIRCRAFT WAR PRODUCTION COUNCIL, INC.

be hardened the surface layer developed by radio-frequency energy is uniform.

The upper bearing case is substantially uniform over some 80 per cent of its length and near the upper end tapers away to zero thickness. The reason for the taper is that a necessary compromise had to be made at this part of the shaft because of the proximity of a spline whose prior heat-treat could not be disturbed. It is interesting to note that although the upper bearing's case depth has tapered at one end the hardness readings remain reasonably uniform almost to the vanishing point of the case. Hardness readings shown are from Rockwell 15N scale where 88 corresponds to 55 Rockwell C.

Case Depth Versus Heat-Treat Time

It was found that the depth of the case developed on this shaft could be controlled to within ±0.001 in. and that for the particular power used its relation to heat-treat time was as shown in Fig. 5. It will be noted from Fig. 5 that the relationship between depth of case and elapsed time of heat-treat is approximately linear up to 1.0 sec. but that as the heat-treat time increases to 1.1 sec. a sharp upturn develops in the curve. Beyond 1.0 sec. small increases of time result in considerable increases in depth of case. This was interpreted as meaning that the temperature gradient between the surface and interior points has become too flat to remain controllable from the surface.

Distortion and Scaling

Because there was no distortion and oxidation was negligible, both the upper and the lower bearing surfaces were thin case hardened *after* having been finish ground to *final dimensions.* During the development work a considerable number of these shafts were carefully checked before and after heat-treatment to establish that no distortion or warping occurred.

Surface Forces

High-speed hardening of a surface layer by induction heat will leave the surface under compression. If the surface layer were thick, the force exerted by this stress would be important, but with thin case hardening the force is negligible. For example: a 1/4-in. square annular ring cut from a shaft, as in Fig. 7, position A, was carefully measured before and after cutting through one side. After cutting the ring closed in slightly but the change in outside diameter was only 0.0013 in. out of 0.630 in.

Microphotographs

Detailed examination of cases developed at depths of 0.009 and 0.020 in. are shown in Figs. 8 and 9. The longitudinal macrosections of test piece

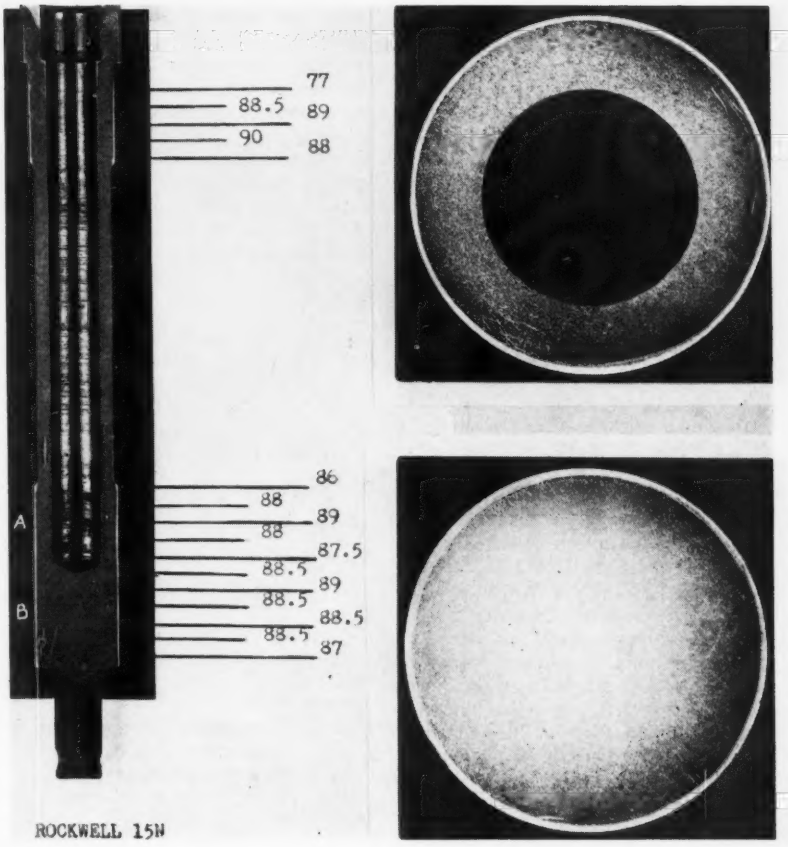

FIG. 7. (*Left*) Macrophotograph. Cross-section shaft. Approx. 0.85×. (*Right, top*) Section A. Approx. 3.40×. (*Right, bottom*) Section B. Approx. 3.40×.

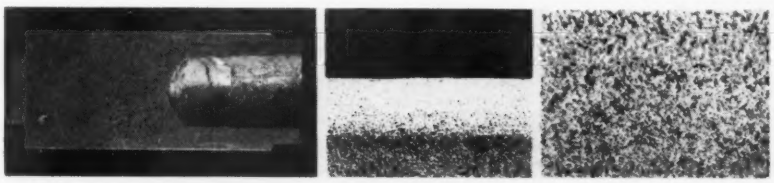

FIG. 8. (*Left*) Macrophotograph. Cross section of test piece No. 176. Approx. 1.10×. (*Middle*) Microphotograph. Surface cross section. Approx. 35×. (*Right*) Microphotograph. Case near surface. Approx. 175×.

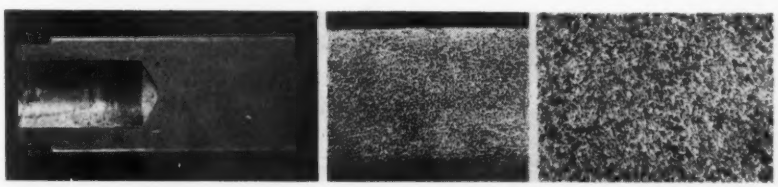

FIG. 9. (*Left*) Macrophotograph. Cross section of test piece No. 161. Approx. 1.10×. (*Middle*) Microphotograph. Surface cross section. Approx. 35×. (*Right*) Microphotographs. Case near surface. Approx. 175×.

176 and 161 are 1.10× and show reasonably well the uniform case developed along the lower bearing surface. They also show the relative depth corresponding to their heat-treat times of 0.7 and 1.0 sec., respectively. The microphotographs of a longitudinal cross section extending from the case through the core show how sharp and definite the transition is from the 30 Rockwell C hardness of the core to the 55 Rockwell C hardness of the case. At the right of Figs. 8 and 9 there is shown a 175× microphotograph of the hardened surface layer taken near the outside edge.

Tempering by Surface Layer

The possibility of a subnormal strength layer having been created by tempering action of the heated surface layer was of considerable interest. The appearance of the microphotograph seemed to indicate that some tempering had taken place. This seemed dubious because of the short time involved. Examination across the case boundary layer with a Vickers hardness tester has thus far failed to disclose any loss of core hardness. Fig. 10 shows a plot of case hardness as a function of depth beneath the surface and it will be noted that it did not dip below 30 Rockwell C. The material, before the original heat-treat, had a hardness of 20 Rockwell C. It is not intended that this limited evidence should be accepted as conclusive. The author has incorporated it only as representing his best present knowledge of the situation. In connection with this same point, it may also be of interest to mention that the point-to-point Vickers test was supplemented by a constant pressure scratch test, wherein a sapphire point was drawn across a polished section so that its track width might be observed under a microscope as an indication of relative hardness in the core, the boundary layer, and the hardened surface. No tests thus far show evidence of the boundary layer having become tempered by the surface heat. Test work along this line of attack is still in progress.

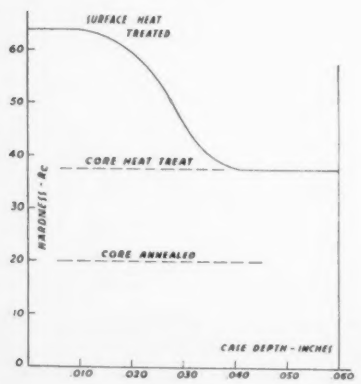

FIG. 10.

It was mentioned above that microphotographs of high-speed heating results should be cautiously interpreted. An example in point is contained in the two 175× microphotographs of the surfaces shown in Figs. 8 and 9. It will be observed that considerable difference exists in the surface structure indicated for the two depths of case shown. However, the two cases had identical hardness as measured by either Vickers or by Rockwell 15N. It may also be observed by metallurgists that these microphotographs show minute quantities of undissolved carbides in the hardened surface layer. This is a point of considerable academic interest and may ultimately lead to more precise knowledge regarding the minimum time and temperature conditions required for carbides to go into complete solution. The question is beyond the scope of the present paper, which has been concerned only with establishing the fact that thin, accurately controlled cases can be created on the surface of hardenable steels with radio-frequency energy.

Temperature Distribution

In the field of surface heating it is of fundamental importance that we know as much as possible about the temperature distribution in the work. The ideal would be an equation that would express the temperature of any particular point as a function of surface temperature, time of heat-treat, and distance from surface. A useful equation applied by Dr. S. Frankel is one based upon flat plate unidimensional heat flow:

$$u = u_0 \left\{ 1 - \frac{4}{\pi} \sum \left[\left(\frac{\sin\left(\frac{(2n-1)\pi x}{2\tau}\right)}{2n-1} \right) e^{-\frac{(2n-1)^2\pi^2 t}{4c^2\tau^2 k}} \right] \right\}$$

Expanded, the equation becomes

$$u = u_0 \left\{ 1 - \frac{4}{\pi}\left[\left(\frac{\sin\frac{\pi x}{2\tau}}{1} \right) e^{-\frac{\pi^2 t}{4c^2\tau^2 k}} \right] - \frac{4}{\pi}\left[\left(\frac{\sin\frac{3\pi x}{2\tau}}{3} \right) e^{-\frac{9\pi^2 t}{4c^2\tau^2 k}} \right] - \frac{4}{\pi}\left[\left(\frac{\sin\frac{5\pi x}{2\tau}}{5} \right) e^{-\frac{25\pi^2 t}{4c^2\tau^2 k}} \right] \cdots \right\}$$

where

- u = temperature of the point in question
- u_0 = surface temperature
- c^2 = $\frac{\text{specific heat} \times \text{density}}{\text{specific conductivity}}$
- k = empirical constant = heat distribution correction
- τ = total wall thickness
- x = distance of point from surface
- t = time in seconds
- e = 2.718

The equation expresses the internal point temperature in the form of a converging series. Solving for the first term only will in most cases be sufficient.

Proper use of the equation requires accurate knowledge of the surface temperature versus time relation since the equation itself was derived for suddenly applied fixed values of surface temperature. Fig. 11 shows actual surface temperature versus time for a particular case hardening job.

The evaluation of c^2 and k is rather involved, since the determining factors vary with surface temperature and with temperature distribution. It will be sufficient for purposes of this paper to give only the results of the calculations. These are summarized in the curves of Fig. 11 and Fig. 12. The curves apply to the wall over the hollow portion of the shaft, as at position A of Fig. 7.

Fig. 11 shows the temperature versus time for the surface layer as compared to that of particular layers located at various depths beneath the surface. The curves shown apply only to a particular part for which the outside diameter was 0.630 in., the wall thickness (τ) was 0.125 in., and the rate of power input to the surface of the steel was 15 kw. per sq.in.

Fig. 12 shows the data of Fig. 11 replotted to show temperature versus depth at a particular time. This derived form of the data is of more direct interest, since it indicates the required heat-treat time for a particular case depth and hardening temperature. Although Fig. 12 applies specifically to the job and power mentioned, it is broadly representative of the general case.

(Continued on page 101)

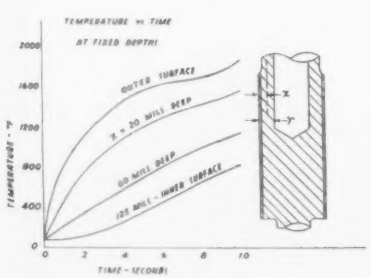

FIG. 11.

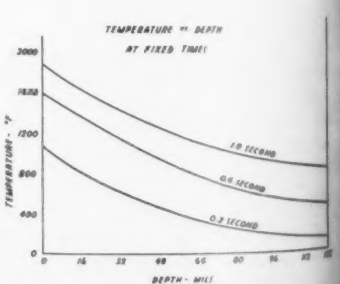

FIG. 12.

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Home from the sky comes a queen of inter-continental flight . . . completing another mission laden with men and materials of war. It is with great Clippers like these that Pan American Airways System has blazed new sky trails all over the world—flightways that have proved invaluable in our present global warfare.

Like other leading airlines, Pan American flies with B. F. Goodrich equipment. Planes fly safely through dangerous icing conditions, thanks to B. F. Goodrich De-Icers. Pilots of land-based Clippers make safer, smoother take-offs and landings on B. F. Goodrich Silvertown Tires. And B. F. Goodrich shock absorption pads, tubing, grommets and Rivnuts also travel with the Clippers.

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B.F. GOODRICH RIVNUTS FOR FASTER AIRCRAFT ASSEMBLY

RIVNUTS are internally threaded tubular rivets accurately machined from highly corrosion-resistant aluminum alloy. By the use of special tools, Rivnuts can be pulled up while working entirely from one side, forming a bulge or head on the under side. This upset is large enough to resist being pulled through the metal skin, even under heavy load. Rivnuts may be used as a nut plate or as a rivet, or both.

No other "blind" fastener has all these features

The Rivnut offers a combination of advantages which make it unique among blind fasteners. It is extremely simple in design—in fact, the only *one-piece* blind rivet that can also be used as a nut plate after installation. It is light in weight, low in cost, quick and easy to install. Because Rivnuts upset by bulging laterally, they expand to fill the hole in the skin and have a spring effect under load. Rivnuts may be inserted in a smaller hole in the skin due to their compact design. Threads are counterbored, thus making it easy to insert the screw. When upset, Rivnuts have a wider bearing area than any other blind fastener. They are made in three screw sizes and a complete range of grip lengths.

Wide range of uses

Although developed primarily as a nut plate for the attachment of De-Icers, Rivnuts have found many other important uses in secondary and, in some cases, primary structure—in metal, plywood or plastics. These uses include: the attachment of landing and navigation light assemblies, instruments, fillets and fairings, Fowler flaps, insulation, and access doors for bullet sealing fuel cells.

Can Rivnuts help you?

If you are engaged in aircraft manufacture or maintenance, chances are you can use Rivnuts to great advantage for applications of the type listed above, or for specialized applications of your own which require "blind" fastening. Why not tell us about any particular assembly problem you may have? We'll be glad to give you our recommendations. Aeronautical Division, The B. F. Goodrich Company, Akron, Ohio.

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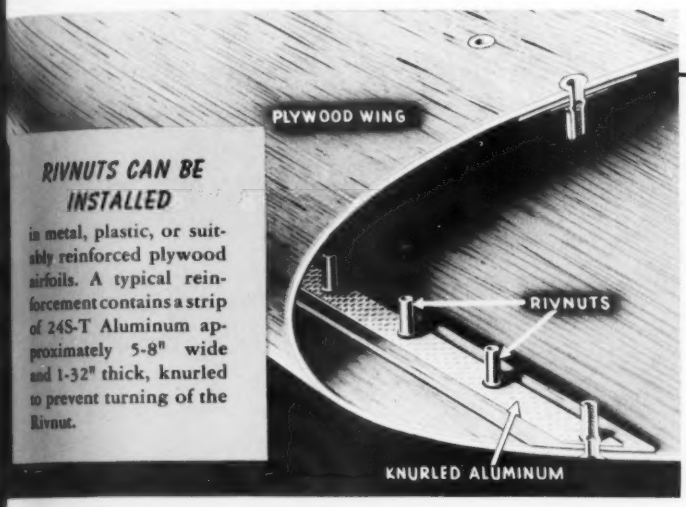
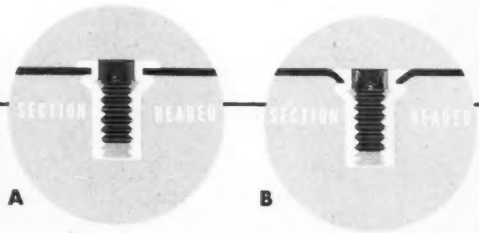


RIVNUTS CAN BE INSTALLED

in metal, plastic, or suitably reinforced plywood airfoils. A typical reinforcement contains a strip of 24S-T Aluminum approximately 5-8" wide and 1-32" thick, knurled to prevent turning of the Rivnut.

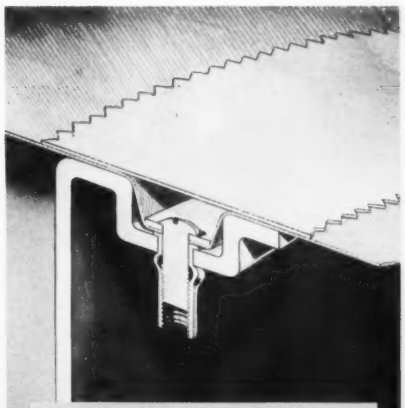


CROSS-SECTIONS

showing three types of Rivnut installations. (A) Flat Head type where absolutely flush surface isn't necessary; (B) Countersunk Head type with dimpled countersink in thin metal; (C) Countersunk Head Type with machined countersink in thicker metal.

ATTACHING ACCESS DOORS

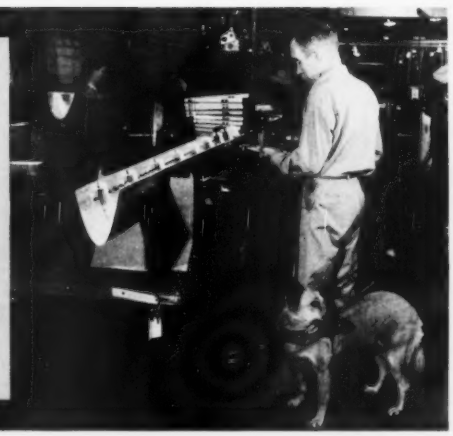
like the one shown on the left is typical of the many uses for Rivnuts in aircraft assembly. Although originally developed as a nut plate for the attachment of De-Icers, Rivnuts now are being used in the attachment of navigation light assemblies, instruments, fillets and fairings, Fowler flaps, insulation, and many others.



Drawing, showing use of Rivnuts in the assembly of cloth-covered wings, ailerons, trim tabs, rudders, elevators, etc.

RIVNUT INSTALLATION IS SO EASY

even a blind man can do it. Right now, in one of the country's leading plants, blind men are heading Rivnuts on important aircraft assemblies and doing it mighty efficiently, too. Unskilled workers can learn Rivnut installation and become highly proficient in a very short time.



GET THIS FREE BOOKLET. Contains data on Rivnut types, sizes, grip ranges, strength and weight. Installation tools are illustrated and described. For your free copy, write today (on company letterhead, please) to The B. F. Goodrich Company, Aeronautical Division, Akron, Ohio.

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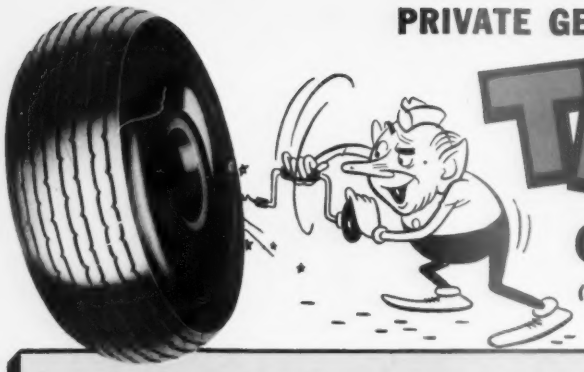

TIRE QUIZ

CAN YOU SCORE 100%?

(Pick correct answer from a, b, and c—see end for score)

1. The weather in Africa causes tires to deteriorate faster than the weather in Russia because . . .

a. Bright sunlight has deteriorating effect on tires. More sunlight in Africa, therefore more deterioration.
b. Terrific sandstorms blast tires in Africa.
c. Desert heat melts tires.

2. Private Jones got bawled out for spilling oil on a tire because . . .

a. It made tire slippery.
b. Oil is extremely harmful to rubber.
c. There's an oil shortage.

3. Tires should be examined regularly because . . .

a. The Army is compiling tread-wear statistics.
b. If bruises and cuts are not discovered in time and repaired, tire may blow out and cause a crash.
c. Treads may be slipping.

4. Tires should be repaired when cut to the cord because . . .

a. Cords will rot; tube will be unprotected; tire may blow.
b. Air friction may set tire on fire.
c. Cords hold tire on rim.

5. Overinflation should be guarded against because . . .

a. The President is trying to curb inflation.
b. Overinflation causes rapid tread wear.
c. Overinflation increases tire weight.

6. Underinflation is harmful because . . .

a. It causes early failure of cord in the tire carcass.
b. It causes plane to bounce when landing.
c. It causes serious tube shrinkage.

7. Valve cores should be checked regularly . . .

a. Because leaks often develop at the valve core.
b. To see if they need lubrication.
c. To prevent valve tap.

8. Valve caps should be on all valves because . . .

a. They make a more streamlined appearance.
b. Caps keep dust, oil, and moisture out of valve; seal air in.
c. They are standard equipment on all Army planes.

9. Deflection ribs are placed on smooth-contour tires to . . .

a. Measure growth of tire in service.
b. Measure thickness of tread.
c. Show when a tire is properly inflated.

10. Proper size tube should always be used because . . .

a. Wrong size will either wrinkle and become pinched or stretch and lose air rapidly.
b. Too small a tube constricts the bead.
c. Too large a tube wastes vitally needed rubber.

WHAT IS YOUR SCORE?

Each correct answer counts 10. 1-a, 2-b, 3-b, 4-a, 5-b, 6-a, 7-a, 8-b, 9-c, 10-a.

This is one of a series of maintenance quizzes prepared for ground crew trainees of the U. S. Army Air Forces Technical Training Command. It is our hope that this series will help all maintenance men get maximum service, safety, and efficiency from military, commercial, and civilian aviation equipment.

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FIRST IN RUBBER

Plastic Working of Magnesium Alloy Sheet

C. E. LEHNHARDT*
The Dow Chemical Company

Introduction

Prior to the advent of present aircraft production requirements, magnesium alloys were used mostly in the form of castings, flat sheet, and extruded shapes. Sheet deformation was done over wooden forms by means of a rawhide hammer and a heating torch. Where bends were long, bending was accomplished in either a press-type brake or a folding-type brake, heat being applied to the sheet by means of a torch. Present production rates have warranted the use of presses and die equipment suitably designed to accomplish the required deformations. Experience gained thereby has indicated the possibility of manufacturing parts formerly thought to be either too costly or impossible in magnesium. The combination of this experience, plus the metallurgic development of improved alloys and better protective treatment, has enabled the manufacturers of aircraft parts to take increased advantage of the high-strength-low-weight ratio of magnesium alloys.

While the metallurgic development has contributed to a large extent to inducing confidence in the use of magnesium alloys in weight-saving applications, improved fabrication methods have kept pace with these developments. It is the purpose of this article to discuss these methods as they apply to the forming of magnesium alloy sheet metal parts.

Plastic Deformation and Its Advantages

The methods employed for forming magnesium alloys differ from those used in the forming of most other metals in that all except the most simple operations must be done at elevated temperatures to obtain sufficient plasticity and elongation to allow the part to be formed or drawn. Fig. 1 shows the effect of elevated temperatures on the tensile strength and elongation of annealed magnesium alloy sheet. The crystallographic form of magnesium is close-packed hexagonal and, at temperatures up to 400°F., has only one set of slip planes (the basal planes), thereby

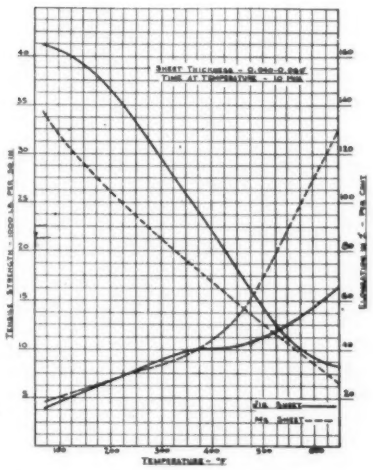

Fig. 1. High-temperature properties of Dowmetal sheet.

definitely limiting the permitted deformation. Above 400° to 450 °F. the pyramidal planes also become active, thereby greatly increasing the capacity for deformation.

Working metals at elevated temperatures and at speeds coincident with the recrystallization rate has several advantages over working them cold. The parts can often be formed in one operation without the necessity of drawing, annealing, and redrawing, thus reducing not only the time involved for making the part but also eliminating the necessity of additional die equipment for deep-drawn parts. Another advantage of the hot forming process is that the allowance for "springback" is not required. This results in simplified die design and the possibility of making parts identical should the material come to the presses in varying hardness.

At the present time, annealed magnesium alloy sheet, designated as Dowmetal Ma and Dowmetal J-1a, is being used for hot formed parts. Dowmetal J-1h (identical to Dowmetal J-1a, but in the hard condition) sheet is used for stressed parts and is formed at a temperature low enough to retain its hard-rolled mechanical properties. Table 1 shows the chemical composition and Table 2, the mechanical properties of these magnesium alloys.

The annealed alloys, Dowmetal Ma and J-1a, lend themselves to hot forming operations because the physical properties noted above are inherent in the metal and are not affected by subsequent heating and cooling. Dowmetal J-1h is somewhat more difficult to form because the temperature to which this material is heated will affect its mechanical properties after cooling. Working temperatures for Dowmetal J-1h should not be over 400°F., while for Dowmetal Ma and J-1a working temperatures as high as 700°F. may be used. Fig. 2 illustrates the effect of heating on the mechanical properties of hard-rolled magnesium alloy sheet after it has cooled to room temperature.

TABLE 1
Chemical Composition of Dowmetal Sheet
Nominal composition—per cent

Alloy	Aluminum	Manganese	Zinc	Magnesium
M	...	1.5	...	Remainder
J	6.5	0.2	0.7	Remainder

TABLE 2
Mechanical Properties of Dowmetal Sheet

Alloy	Tensile Yield Strength, Lbs. per Sq.In.	Ultimate Tensile Strength, Lbs. per Sq.In.	Elongation, Per Cent in 2 In.
Ma	16,000	32,000	15
J-1a	24,000	42,000	16
J-1h	35,000	45,000	8

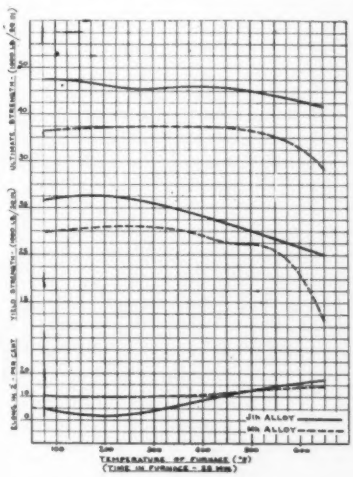

Fig. 2. Effect of heating on properties of hard-rolled Dowmetal sheet.

Presented at the Aircraft Production Session, Eleventh Annual Meeting, I.Ae.S., New York, January 25-29, 1943.

* Dowmetal Fabrication Division.

HOW "VINYLITE*" PLASTICS

HELP TO MEET TODAY'S CRITICAL NEEDS

They are immediately adaptable to established fabricating methods and offer an unusual combination of useful properties

ONE OF THE MANY reasons why VINYLITE Plastics have attained front-rank importance in vital production is the variety of ways by which they can be fabricated—frequently without major changes in existing equipment and manufacturing methods built around other materials. Of equal importance is the fact that these versatile plastics offer industry an unusual combination of properties unobtainable with other materials.

For example, one VINYLITE Resin Compound can be *extruded* into flexible, non-oxidizing, abrasion- and flame-resistant insulation for electrical wire and cable. Another VINYLITE Elastic Plastic can be *injection molded* into flexible, rubber-like shapes and forms, such as grommets and terminal insulators. Other types can be applied to cloth by *knife-* or *calender-coating* to provide waterproof clothing and paulins that will remain flexible even at −50 deg. F. Rigid VINYLITE Plastic Sheets can be *punched* and *printed* to form accurate *calculating* instruments that are noted for their exceptional dimensional stability. VINYLITE Resins, in solution, can be *sprayed* into cans, containers, drums, and tanks to provide non-toxic, chemical-resistant linings.

The opposite page presents information on the properties, forms, fabricating methods, and applications of VINYLITE Plastics and Resins. For more detailed information, write for technical literature, or call upon our Engineering Staff and Development Laboratories for assistance in solving your essential production problems.

Plastics Division
CARBIDE AND CARBON CHEMICALS CORPORATION
Unit of Union Carbide and Carbon Corporation

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30 EAST 42ND STREET, NEW YORK, N. Y.

"VINYLITE" ELASTIC PLASTICS

These are a relatively new group of VINYLITE Plastics with rubber-like or elastomeric properties. They are produced in a variety of forms, ranging from soft to semirigid. They possess great toughness, and good resistance to continued flexing, and to severe wear and abrasion. Tensile strength is higher than that of most rubber compounds. Their electrical insulating properties are excellent. They are not subject to oxidation. By correct choice of plasticizer, they can be made non-flammable and highly resistant to water, oils, and corrosive chemicals. They are available in a wide range of colors, either translucent or opaque, or can be supplied in their natural, colorless, transparent state. Since all of the VINYLITE Elastic Plastics are thermoplastic, no curing or vulcanizing is required. They are more affected by temperature changes than is rubber, but their operating range is wide, some types remaining flexible at –50 deg. F., yet tack-free at 200 deg. F.

VINYLITE Elastic Plastics are supplied as sheeting and as compounds for calendering onto cloth, as molding and extrusion compounds, or as powdered resins for those industries that, like the rubber industry, possess adequate compounding equipment.

Applications of VINYLITE Elastic Plastics include many products formerly made of rubber, as well as many others that take advantage of their unique properties. Some of these are: non-flammable insulation extruded around wires and cables; flexible, waterproof cloth coatings for rainwear, upholstery, inflatable equipment, and paulins; extruded, transparent or opaque, chemical-resistant tubing; molded grommets, and wire terminal insulators.

"VINYLITE" RIGID PLASTICS

Produced from unplasticized vinyl resins, VINYLITE Rigid Plastics possess a combination of properties found in no other thermoplastic material. Because of their extremely low water absorption, these plastics remain dimensionally stable under widely varying atmospheric conditions. They are outstanding in their resistance to alcohols, oils, and corrosive chemicals. They have high impact strength and tensile strength. They are odorless, tasteless, and non-toxic. They do not support combustion. They are available in a wide range of colors, translucent or opaque, and also in colorless, transparent forms. They are supplied as rigid sheets or as molding and extrusion compounds. Rigid sheets can be fabricated by forming, drawing, blowing, spinning or swaging, and can be punched, sheared, sawed, and machined on standard metalworking tools. Molding compounds are suitable for both compression and injection molding. Extrusion compounds give highly finished continuous rigid rods, tubes, and shapes directly from the die.

Applications of VINYLITE Rigid Sheets include precise calculating and navigating instruments of high dimensional stability; shatterproof gauge glasses and dials for radios, clocks, and instruments; name plates, transparent aircraft enclosures; storage battery separators. Compression-molded applications include transcription records and printing plates; injection-molded uses include safety-goggle frames, combs, pen and pencil barrels. Rigid extrusion compounds are produced as continuous rods, tubes, and shapes by screw extrusion. They are readily fabricated with standard woodworking or metalworking equipment.

"VINYLITE" RESINS FOR SURFACE COATINGS

Correctly formulated and applied, VINYLITE Resins yield finishes of unusual toughness, gloss, adhesion, and chemical resistance. They can be applied by spraying, knife-coating or dipping to a wide variety of surfaces, such as metal, cloth, paper, and concrete. Prepared by dissolving resins in organic solvents, these finishes can be modified with a wide variety of pigments, dyes, and plasticizers. These resins are generally not employed with other film-forming bases, therefore, coatings formulated from them exhibit the desirable features of VINYLITE Resins alone. Drying is solely by evaporation of solvent, and finishes can be either air-drying or baking types.

Applications of vinyl chloride-acetate resins for coatings include container linings, stop-off lacquers for electroplating, corrosion-resistant linings for processing equipment, wall-tile finishes, heat-sealing paper coatings, cement finishes, and waterproof cloth coatings. Coatings based on vinyl butyral resins are also used for waterproof cloth coatings, as on rainwear, hospital sheeting, paulins, and inflatable equipment. Coatings based on these latter resins can be made heat-curing through proper modification.

"VINYLITE" RESINS FOR ADHESIVES

Unusual toughness, resiliency, and impact resistance are characteristic of adhesives made of VINYLITE Resins. These resin adhesives are widely used as bonding agents for such materials as cellophane, cloth, paper, cardboard, porcelain, metal, mica, stone, leather, wood, and plastic sheets and film. They are available as powders for the compounding of adhesives, or as solutions sold under the trade-mark "VINYLSEAL." The latter are especially recommended for bonding impervious materials, such as metals, and the urea and phenolic plastics. Their bonding strength is comparable to that obtained with soft solder. An oustanding example of their use is the lamination of cores of small electric motors. By the addition of plasticizers, adhesives based on VINYLITE Resins can give almost any degree of flexibility desired.

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RESINS FOR ADHESIVES
RESINS FOR SURFACE COATINGS

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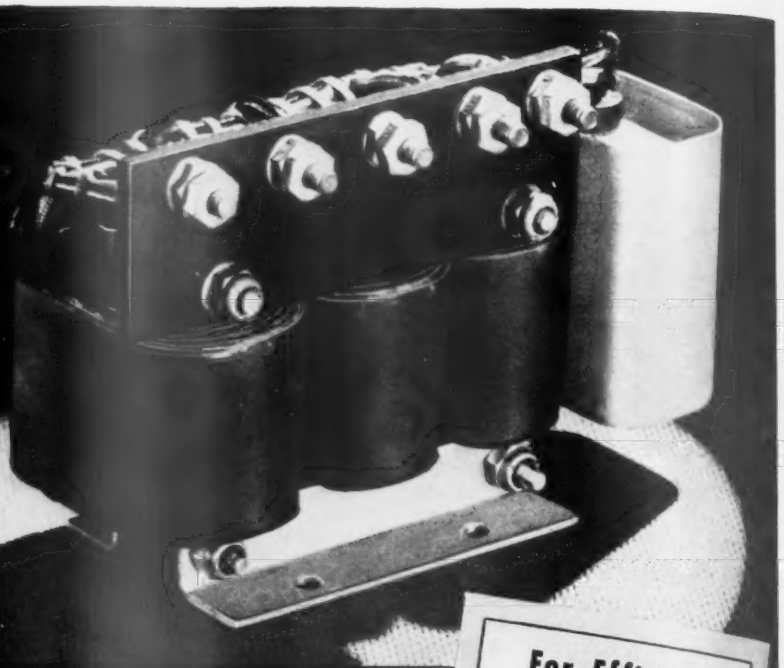
G. E. ANNOUNCES



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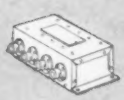

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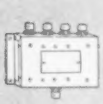

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Equipment

Presses

Either a hydraulic press or a mechanical press, slowed down, may be used for drawing magnesium alloys. The hydraulic press has the advantage of controllable speed during the drawing operation. The press should be designed for both hand and automatic control—the hand control to be used when "inching" of the ram is required as in delicate drawing operations or where extremely slow speeds are desirable; the automatic, with a ram speed of 75 to 200 in. per min., for production operations. The size and capacity will depend largely upon the type of work to be handled and also upon such factors as material thickness and size and shape of the finished article.

It is desirable to have at least a double-acting press either with both rams operating upper platens or with one upper ram and a bottom cushion. In many cases a triple-action press will be found useful, especially where stripping action is desired. Single-action presses can be used but in many cases will require cumbersome spring installations for holding pressure; however, pneumatic cushions can usually be installed to overcome this handicap.

For light repetitive production work a 200-ton press with a lower cushion is suitable. If, however, extremely large parts are to be fabricated or rubber forming is to be resorted to a larger press will be indicated. The Guerin process using rubber made to flow hydraulically in a confined area requires a pressure of about 1,000 lbs. per sq.in. Therefore, a 400-ton press will only accommodate about a 24-in. square rubber retaining box. Platen size, open and shut heights of the press will be determined by the die requirements.

Inclinable mechanical presses are suitable for blanking and punching operations.

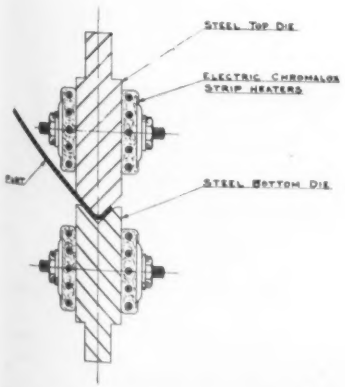

Fig. 3. Electrically heated press brake die.

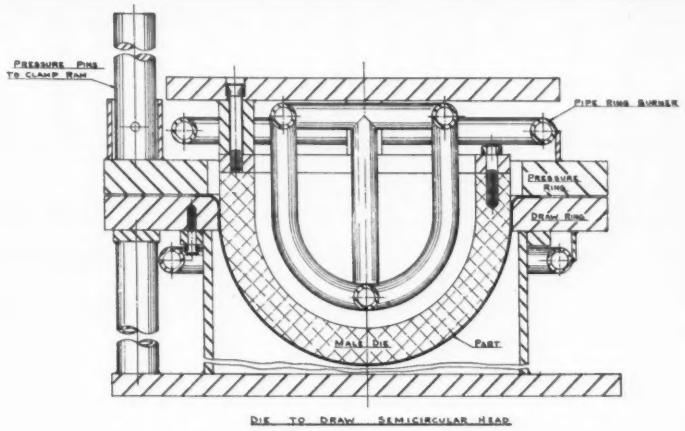

Fig. 4.

Brakes and Bending Rolls

Magnesium alloys may be bent in either the leaf-type or the press-type brake. The press-type brake is preferred because the leaf-type brake tends to concentrate the deformation at the clamping edge and cause fracture. It is also much easier, with the press-type brake, to provide heat as shown in Fig. 3. When this is done, care must be taken that heating the bending dies will not unduly strain the mechanical mechanism of the press. Ordinary bending rolls are suitable for rolling cylindric magnesium sheet parts.

Tools

Blanking Tools

Die design for blanking magnesium alloys differs only slightly from that used for blanking other metals such as steel, brass, or aluminum. The main difference is in the close clearance required between the punch and the die. The die is usually made of hardened tool steel and the punch of tool steel is allowed to remain soft so that it can be sheared into the die. For short runs ordinary mild steel cyanide hardened dies and punches give excellent results. If dies and punches are to be hardened and ground, it is recommended that die clearance be held to 0.0015 to 0.002 in. in order to minimize the characteristic rough flaky fracture of a sheared magnesium edge. Another means of improving the sheared edge appearance is by machining a slight rake (3° to 5°) on the punch. Sheet shearing blades should also have a slight rake and should be set with as little clearance as possible.

Drawing Dies and Die Design

Drawing dies used for forming magnesium alloys do not differ greatly from those employed for forming other materials. The main difference is that provision must be made for heating.

Draw rings and pressure pads are generally made of mild steel but should be annealed before final machining to relieve stresses. Tool steel may be used, but because of its higher initial cost its use should be restricted to high-production dies. Nitrided steels may prove advantageous in diminishing pickup. If, however, mild steel dies are highly polished and well lubricated, they will prove entirely satisfactory. Material thickness should be sufficient to withstand the holder pressure and to resist warpage at elevated temperatures.

The entering radius of the drawing edge should be from 4 to 15 times the sheet thickness, depending upon the depth of draw, nature of the draw, and size of the finished part. In general, a $^3/_8$-in. radius is satisfactory for 0.064-in. thick sheet. The influence of the radius upon the success of the draw is complicated by the fact that two definite but opposing factors are at work. The larger the radius, the less the friction, conversely, the smaller the radius, the greater will be the bending strains as the metal is drawn over the die, making deep draws difficult. Large radiuses will increase the tendency of some draws to pucker.

The male die, or punch, may be made of steel, cast iron, aluminum, or magnesium, either cast or in plate form. Aluminum or magnesium castings having the advantage of easy machinability. The punch radius should be as liberal as possible.

The coefficient of thermal expansion of magnesium alloy is greater than that of steel. Roughly, steel expands one-third as much as magnesium. For this reason, steel dies must be made slightly oversize in order that the finished magnesium part will not be undersize. Therefore, in designing steel dies, one should multiply all die dimensions by the factor 1.0040 if the dies are to be run at a temperature of 600°F. Dimensions for aluminum dies are

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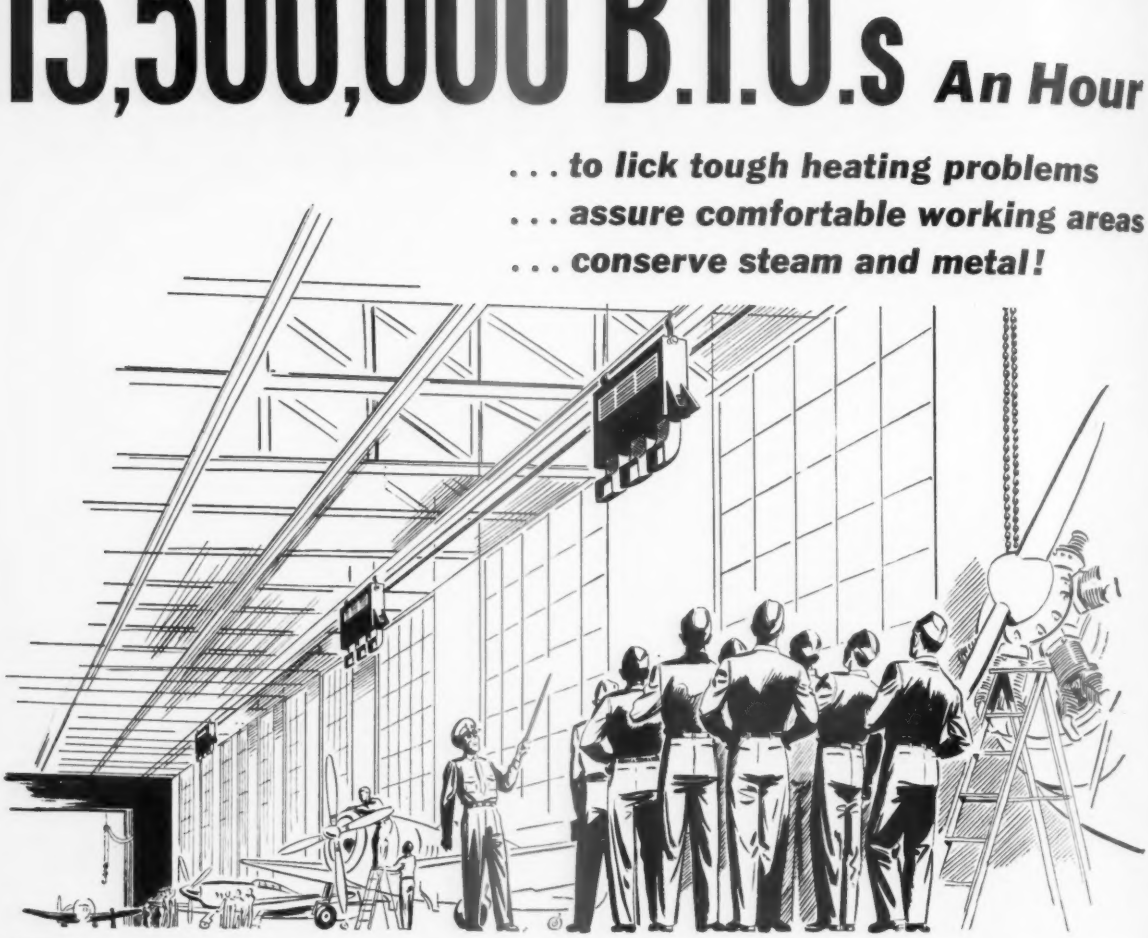

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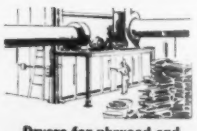

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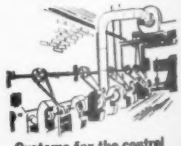

Systems for the control of Dust and Fumes

multiplied by the factor 1.0017. Magnesium alloy dies are made to the size of the finished part.

The clearance between the female die and male punch should be at least equal to the metal thickness, and, for deep draws where considerable thickening is encountered, it should be sufficient to prevent binding.

Fig. 4 illustrates a steel draw ring and aluminum punch die designed to form 0.051-in. magnesium-alloy sheet into a hemispherical tank head 13 in. in diameter.

Forming dies are generally heated with gas-fired burners automatically controlled. Sufficient burner capacity must be provided to maintain the desired temperature uniformly over the entire die surface. A standard-type burner that has proved satisfactory is made from $^3/_4$- or 1-in. standard pipe bent to the desired shape and drilled with No. 40 holes on $^1/_2$-in. centers. These burners are placed $^5/_8$ in. from the surface being heated. Heating may also be effected by the use of electrical heating elements that are often used to advantage; however, difficulty is encountered in designing heating units for odd-shaped dies. To avoid the danger of overheating, burners must be placed so that the flame does not impinge on the material being drawn.

For most work it is imperative to have the heating units thermostatically controlled. In gas-fired installations one thermocouple is provided for each burner and is placed as close as practical to the surface that the burner is to heat. These thermocouples, through the medium of automatic pyrometers, control the air-gas mixture to the burners. They will control die temperatures to within $\pm$ 5°F.

Drawing Lubricants

Magnesium-alloy sheet and the die surfaces must be well lubricated before any drawing operations are attempted in order to prevent scoring or galling of the drawn part and pickup on the die surfaces. A suitable drawing lubricant for magnesium should possess the following desirable properties:

(1) Be easy to apply—evenly and smoothly.

(2) Have a low coefficient of friction.

(3) Have good film strength.

(4) Be able to sustain a temperature of 600° to 700°F. without breaking down.

(5) Be as chemically inert as possible so as to prevent damage to either the die equipment or the drawn part.

(6) Leave no heavy or burned-on residue, which is difficult to remove.

(7) Have no toxic effect upon the operator.

Twenty per cent graphite suspended in tallow makes a satisfactory lubricant.

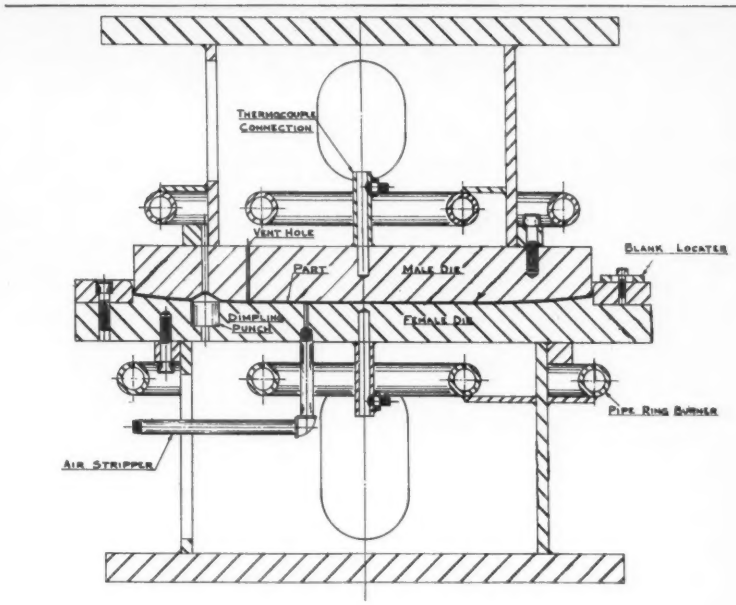

Fig. 5. Die to form aircraft wheel fairing.

A similar lubricant, sold under the name of Lubrico Roto-jector X-32 grease, is also satisfactory. Both of these lubricants are applied by buffing on to the drawing surfaces of the die. Colloidal graphite suspended in carbon tetrachloride in the ratio of 1 to 160 can be sprayed on the magnesium sheet and is proving desirable for general drawing operations.

Cleaning Mediums

After the forming operation has been completed, the part may be cleaned in a solution of 8 per cent chromic acid plus 5 per cent nitric acid. A dip of from 3 to 5 min., at room temperature, is usually sufficient. This solution has a slight etching action. Another cleaner consists of 15 per cent chromic acid solution used near boiling temperature. Care must be exercised in using this cleaner, since the fumes are harmful to the nasal tissues. Cleaning should be carried on under well-ventilated hoods. Both cleaners require a pure aluminum tank.

Fabrication

Blanking

Thin magnesium alloy sheet may be blanked or punched in the same manner as other metals. When blanking is carried out, using ordinary dies, material greater than 0.064 in. in thickness will show a flaky fracture. If dies are designed with close clearances as described under "Blanking Tools," this difficulty will be remedied. Heating the material to 500°F., will also overcome this tendency and is recommended for thick sheets. When heating is necessary, dimensional changes because of subsequent cooling must be considered.

Bending

This method of working magnesium alloys is used extensively in the manufacture of stringer clips and stiffener elements in aircraft structures that do not lend themselves to high-strength magnesium-alloy extrusions. Fig. 3 shows the application of electrical heating elements to the forming dies in a press-type brake. Gas-fired burners have also been successfully used for heating of this type. Experimental work now being carried on indicates that Dowmetal J-1h may be successfully bent to a $4t$ bend radius through 90° at 350° to 400°F., while Dowmetal alloys J-1a and Ma will bend, at 600°F., to a $1t$ bend radius through 90°.

Large compound radiuses may be formed cold in the press brake by passing the sheet between the operating dies.

Hand Forming

It is still customary to employ hand forming where quantity requirements are small and the cost of production die equipment is not warranted or where intricate contours are to be developed.

Simple bends can be made by using a soft-jawed vise or similar clamping device to hold the part to be formed, and, while keeping the part warm by means of a torch, hammering it to the desired shape with a leather maul.

More complicated parts are usually formed over wooden or metallic dies. The metallic dies, although more expensive, are longer lived because of their ability to withstand working impacts

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at elevated temperatures. Magnesium alloy plates or castings are used for this type of die because of their machinability and because they possess the same thermal expansion coefficient as the material being formed. The die and blank are warmed, the blank is clamped to the die surface, and deformation is carried out by means of blows from a leather maul.

Rubber Forming

Perhaps the most widely used process for working magnesium-alloy sheet into shapes requiring only comparatively shallow forming and slight drawing action is the Guerin process. This process has found much favor in pressings, such as aircraft wing ribs, door reinforcement panels, etc.

It is customary, in adapting this process to magnesium-alloy forming, to use heated dies. This is accomplished by placing the dies on a heated platen or hot plate or, for more complicated dies, by inserting heating elements in the die itself. Where parts are relatively small and flat, they will absorb sufficient heat for forming from the dies; however, material for larger and more intricate parts should be preheated before being placed into position on the dies.

Ordinary rubber, of about 70 Durometer, is suitable for forming at temperatures of 250° to 350°F., but where higher temperatures, up to 450°F., are required one of the synthetic rubbers, such as Goodyear Tire & Rubber Company's Chemigum, is more suitable. Sticking of the rubber to the formed part may be diminished by the application of cornstarch or some similar material to the sheet being formed.

Shallow Draws

When parts are to be made in large quantities or where extreme accuracy is required, it is advisable to use steel die equipment. Fig. 5 shows such a die designed for forming a wheel fairing. Dies for such work are designed to operate at 600°F. Parts of this type are not so much drawn as pressed to shape—actual material flow being at a minimum. This is accomplished by forming between mating dies that press the metal in its "dead soft" state.

Deep Drawing

The art of deep drawing magnesium alloys has been an interesting development and has been the step forward required to produce such aircraft parts as engine oil tanks, nose spinners, wheel dust covers, hub caps, and many other similar parts. Fig. 6 shows details of a die designed for drawing hub caps. Deep drawing cylindrical cups to a depth of one and one-half times their diameter in a single draw, requiring a reduction of 60 to 65 per cent, is not uncommon by this hot forming method. In cold drawing steel it would be necessary to draw to a larger diameter, anneal, and redraw to obtain similar results. Square junction boxes have been drawn to a depth equal to their side dimensions. Fig. 7 shows several small parts formed by this method.

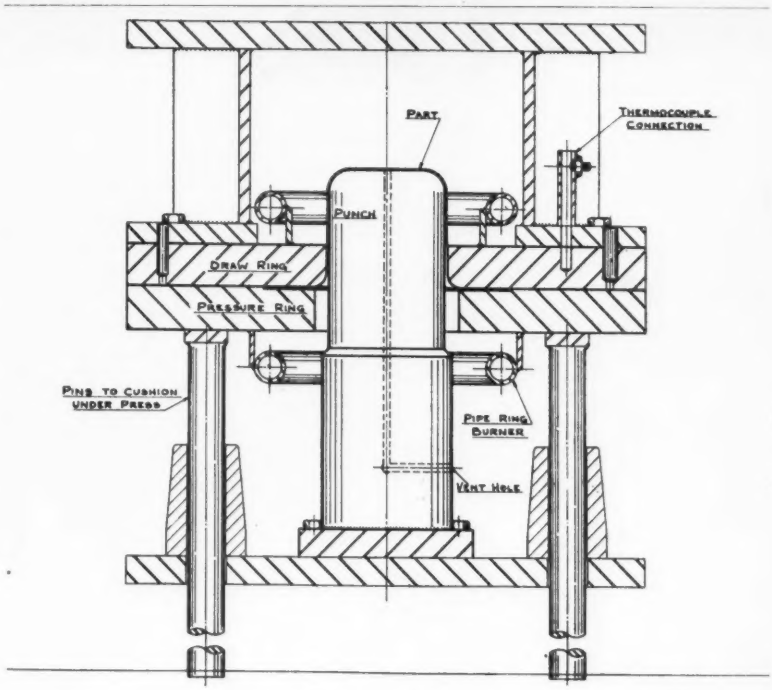

FIG. 6. Die to draw hub cap.

The sheet stock is either bandsawed or blanked to the desired blank shape and lubricated on both sides with one of the lubricants previously described. A lubricant should also be worked into the die surface. It is customary to preheat the blanks to forming temperature in a gas-fired oven or by similar means. The advantage of this, compared to placing cold sheet in the dies, is fourfold. It assures proper drawing temperature, minimizes distortion due to internal stresses, keeps the dies at a uniform temperature, and increases the production rate.

The pressure pad should be adjusted to impart only sufficient pressure to the blank to prevent wrinkling. If the clamping pressure is too great, the punch will have difficulty in drawing the sheet between the clamping surfaces, with a resulting thinning of the drawn part or even rupture due to tension failure. The limitations of the machine often impose minimum and maximum pressure for clamping. Pressure may be reduced by placing spacers or shims, approximately as thick or slightly thicker than the material being drawn, between the clamping surfaces, or the die may be designed with a recess for the sheet. It is difficult to predict what the clamping pressure should be; only assumptions can be made and the proper pressure determined by trial. The practice of roughening the clamping surfaces, cutting retainer grooves or omitting lubricants from certain areas of the blank in order to obtain frictional resistance to control material flow at critical points when drawing odd-shaped parts may be applied to the drawing of magnesium alloys.

FIG. 7. Typical drawn parts.

When forming small parts, it may not be necessary to heat the male punch, since it will absorb enough heat from the draw ring burners. In fact, it is often advantageous to cool the punch when

(*Continued on page 101*)

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TODAY the only aim of this constant speed, lighter weight propeller is to help win the war.

TOMORROW its *fully* automatic pitch change is destined to help America's family-size planes produce more and faster miles per gallon. By making the operation of such planes *simpler*, and *more economical* it will help to speed the day of universal flying.

WICKWIRE SPENCER AVIATION CORPORATION

Blue Island, Illinois (Subsidiary of Wickwire Spencer Steel Company)

Magnesyn Remote Reading Compass*

D. W. SMITH†

Bendix Aviation Corporation

Necessity for a Remote Reading Compass

The trend in design of present-day aircraft makes it highly important that magnetic compasses be located in an airplane, not with respect to the point of observation but in a place as free as possible from local magnetic disturbances. This means a location for the magnetic element remote from the engines, machine guns, moving turrets, and armor plate and brings up the necessity of providing indicators that will show the magnetic heading of the airplane at several observation points, such as the pilot's, copilot's and navigator's positions.

The Pioneer Magnesyn remote reading compass has been designed to fulfill these requirements and provides a compass system that is light in weight and simple in construction and one that provides the accuracy demanded for modern aircraft navigation.

History

In the process of developing the Magnesyn compass, various types of remote reading compasses were experimented with and discarded one by one because of inherent weak points that are not to be found in the Magnesyn type of compass.

The following remote reading compasses were tried and developed to the point where a model was made and sufficient testing carried on to determine their respective values and weaknesses.

Jumper

The Jumper was a 100 per cent d. c. compass, nicknamed "Jumper" because of the solenoid action causing momentary contact and positioning of the indicator element. This model made use of the slave or follower magnet principle, carrying with the compass follower magnets a pair of contact arms. These were used to apply power across a wound toroidal transmitter coil when the solenoid was pulsed by the making and breaking of d.c. relays.

The compass-indicator stators, wound and tapped in a manner similar to the transmitter coil, set up a unidirectional field in the indicator coil when power was applied to the transmitter. The indicator rotor magnet was thereby pulled into line to correspond with the angular relation of the compass follower magnets to the transmitting coil.

Contact trouble, compass pull, and unevenness of pointer indication provided sufficient reasons to abandon this model for a more elaborate system.

Coupling Autosyn with Induction Motor Follow-Up

This compass was comprised of a magnetic compass element with an electrical take-off. The output of the take-off was fed into a coupling or combining Autosyn, which was geared to an induction motor, functioning to turn the coupling Autosyn to a null position and, at the same time, turn a transmitting Autosyn for working remote Autosyn indicators.

This model behaved very well; the heading indications were smooth, contact trouble was no longer a major problem, and the take-off element had almost zero pull on the compass, but the weight and complexity of the system had increased. Because of the low signal value received from the take-off element, it was necessary to provide a follow-up system, which meant an electronic amplifier, and the final model, while much improved, was quite heavy and required considerable power to operate.

Chaser Type

In an effort to reduce the size and weight of the compass, the coupling Autosyn was eliminated and the take-off element was rotated under the compass by means of an induction motor follow-up system, which chased the take-off element to a null position with respect to the compass magnets. This model was designed for minimum weight and the resulting compass weighed approximately one-half as much as the previous system. The reduced weight of moving parts allowed a smaller induction motor to be used. This, coupled with a newly designed amplifier, resulted in considerable reduction of the power consumption.

This model, aside from the number of parts and the fact that a vacuum-tube amplifier was still needed, was a fairly satisfactory compass.

Slave Magnet Type

A slave magnet was next employed in view of producing a greater output from the pickup element. This method was tried both in a model using a follow-up system and, later, in a model utilizing the Magnesyn indicator. In each case it was found that the added friction, compass pull, and lack of stiffness in coupling between the slave magnet and the compass element resulted in undesirable features that affected the accuracy and performance of the magnetic compass itself.

Magnesyn Compass

Working on a new principle, eliminating the faults and weaknesses of previous experimental models and yet producing accurate remote indications, the Magnesyn type of compass was finally developed. It is this compass that will now be described in detail. (Figs. 9 and 11.)

Theory of Magnesyn

The exposition of the Magnesyn theory can well be divided into the following parts: (a) physical units involved, (b) development of second harmonic flux, (c) development of second harmonic voltage, (d) relationship between rotor position and voltages, and (e) flow of second harmonic currents.

Physical Units Involved

Referring to Fig. 1, consider the elements required for a Magnesyn transmitter and receiver or indicator.

Both units are comprised of circular laminations on which are wound continuous toroidal windings. The laminations are made of special magnetic material and the toroidal winding has an input and output lead with two tap leads taken at one-third the electrical distance around the ring.

Consider the two coils wired in parallel with both coils excited with an alternating current and that in the center of each coil is a permanently magnetized magnet free to rotate.

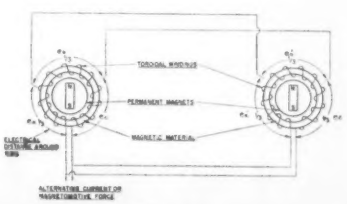
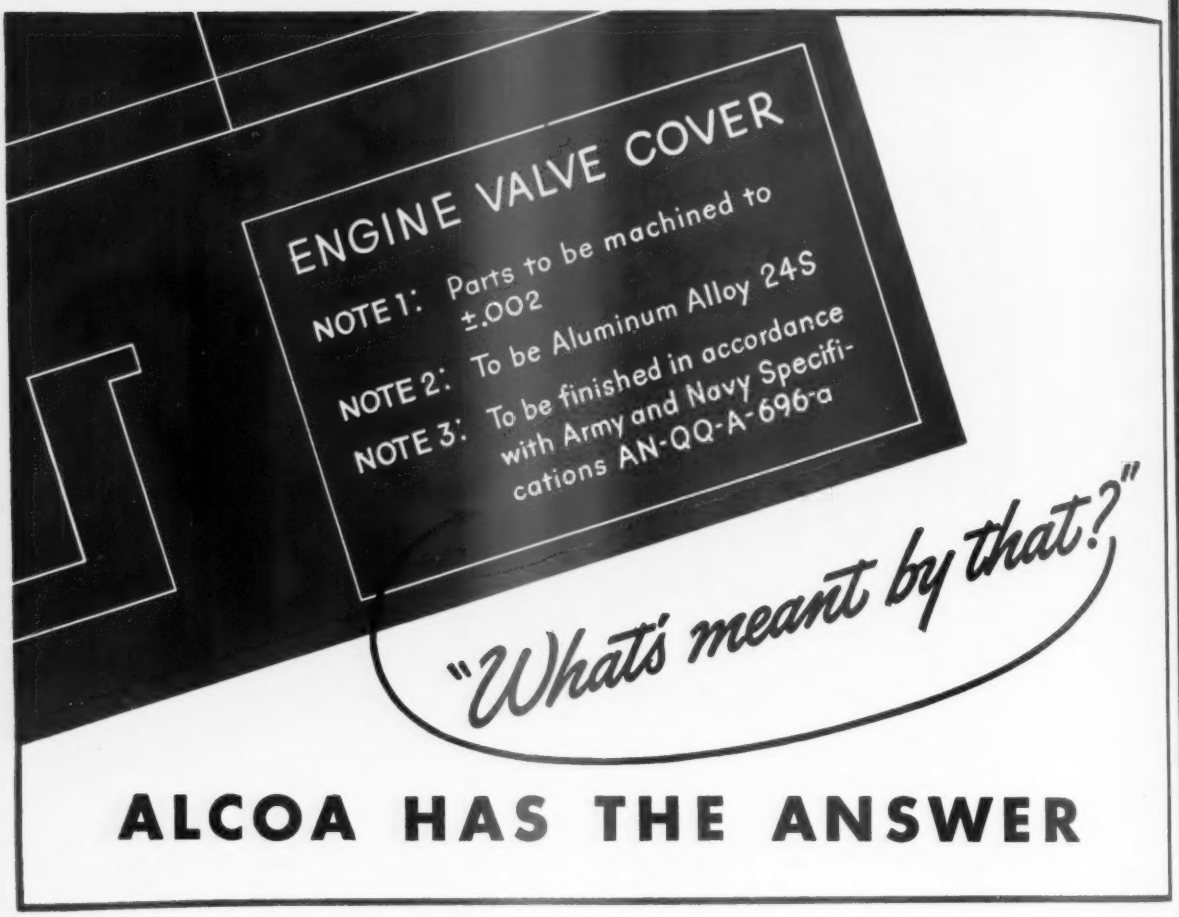


Fig. 1.

Presented at the Radio and Instruments Session, Eleventh Annual Meeting, I.Ae.S., New York, January 25–29, 1943.

* Copyright 1942 by Bendix Aviation Corporation.

† Assistant Department Head, Compass Laboratory, Pioneer Instrument Division.


ENGINE VALVE COVER
NOTE 1: Parts to be machined to ±.002
NOTE 2: To be Aluminum Alloy 24S
NOTE 3: To be finished in accordance with Army and Navy Specifications AN-QQ-A-696-a
"What's meant by that?"

ALCOA HAS THE ANSWER

There are several Government-approved oxide-coated finishes for aluminum, which may be applied by the Alumilite* process. Each has its own identifying symbol and name. You'll certainly run across them in your war work, if you're making aluminum plane or instrument parts which require protective finishes.

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*Patented process

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It is proposed to show that with the proper excitation and coil conditions the rotation of the transmitter magnet will cause the receiver magnet to follow in the same direction and with the same angular displacement.

Development of Second Harmonic Flux

Consider first the magnetic circuits to be found in the transmitter unit.

Looking at the diagram in Fig. 2, it can be seen that the permanent magnet will cause a magnetomotive force to be set up in each half of the annular core, which we will call $H_{d.c.}$, and that the core will be bisected by the axis of the poles of the magnet. Furthermore, inasmuch as the core is made of a homogenous material, symmetric in shape and concentric with relation to the magnet, the reluctance of the two magnetic paths will be the same and the $H_{d.c.}$ will be equal in the two halves of the ring.

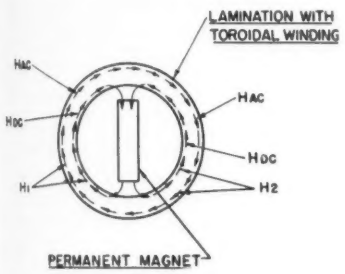

FIG. 2.

The alternating exciting current will cause an alternating magnetomotive force to be set up in the core, which will be considered at a specific time to cause a flow of flux in the coil in a clockwise direction.

With respect then to the exciting magnetizing force, $H_{a.c.}$ the d.c. magnetizing force is positive in one-half of the core and negative in the other half.

Then the total magnetomotive force in one-half is

$$H_1 = H_{a.c.} + H_{d.c.} \qquad (1)$$

and in the other half is

$$H_2 = H_{a.c.} - H_{d.c.} \qquad (2)$$

Magnetomotive force H_1 gives rise to a flux density B_1, which is made up of two component parts—namely, $B_{a.c.}$, which is common to both halves of the core and varying at the same frequency as $H_{a.c.}$, and an additional flux density B_x, which exists because of the presence of $H_{d.c.}$ combined with $H_{a.c.}$ or

$$B_1 = B_{a.c.} + B_x \qquad (3)$$

Likewise

$$B_2 = B_{a.c.} - B_x \qquad (4)$$

Solving Eqs. (3) and (4) for $B_{a.c.}$

$$B_{a.c.} = (B_1 + B_2)/2 \qquad (5)$$

Solving Eqs. (3) and (4) for B_x

$$B_x = (B_1 - B_2)/2 \qquad (6)$$

Considering the magnetization curve of a special magnetic material having no hysteresis, these flux densities will have the following relationship:

Referring to Fig. 3, Curve 3a shows the time variation of the exciting magnetomotive force $H_{a.c.}$.

Curve 3b is a curve of the total magnetomotive force in one-half of the core where $H_1 = H_{a.c.} + H_{d.c.}$.

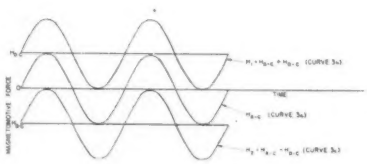

FIG. 3.

Curve 3c is a curve of the total magnetomotive force in the other half of the core where $H_2 = H_{a.c.} - H_{d.c.}$.

Fig. 4 is a magnetization curve of the material comprising the core of the coil. For simplicity the curve has been shown without hysteresis.

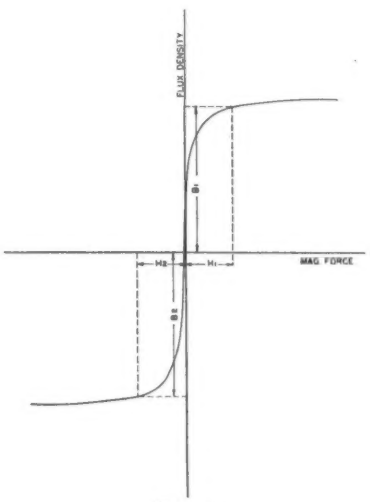

FIG. 4.

On Fig. 5, Curve 5a is a diagram of flux densities in one-half of the core due to the presence of magnetomotive force H_1, the curve being derived from values taken from the curve Fig. 4.

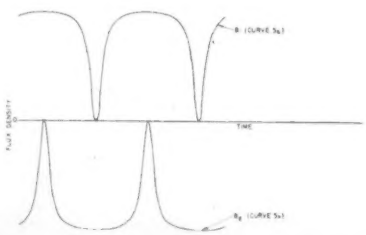

FIG. 5.

Curve 5b, Fig. 5, is a curve diagram of flux densities in the other half of the transmitter core due to the presence of H_2 curve values being taken from Fig. 4.

Curve 6a, Fig. 6, shows the time variation of the flux density $B_{a.c.}$, which is common to both halves of the core.

Curve 6b on this diagram is a curve of flux density B_x due to the combining of $H_{d.c.}$ and $H_{a.c.}$, and it can be seen that it is a curve of flux density varying with double the frequency of the fundamental flux $B_{a.c.}$ or a second and even harmonic flux.

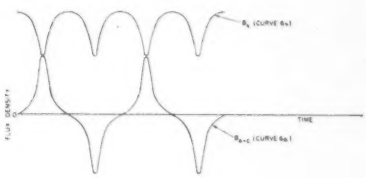

FIG. 6

Development of Second Harmonic Voltage

Now consider a toroidal winding on a core, similar to the ones previously discussed, with a single tap as shown in Fig. 7. Then the exciting voltage, E, impressed across the coil will be:

$$E = e_1 + e_2 = e_{a.c.}$$

then

$$e_1 = -k\frac{dB_1}{dt} = -k\left(\frac{dBAC}{dt} + \frac{dB_x}{dt}\right) = e_{a.c./2} + e_x$$

and

$$e_2 = e_{a.c./2} - e_x$$

where

$$e_x = -k\,(dB_x/dt)$$

Voltage e_x constitutes a voltage of a frequency double that of the exciting voltage E or a second harmonic voltage that is a maximum at opposite points on the coil coincident with the axis of the magnet.

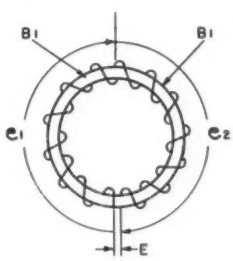

FIG. 7.

Relationship Between Rotor Position and Voltages

If the coil is now tapped at two places 120 electrical degrees apart, as shown in Fig. 1, the relation of the three-phase

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second harmonic voltages will be as shown in Fig. 8.

It can be shown that when the axis of the poles of the magnet is parallel to the electrical axis of any one phase the second harmonic developed across this phase is a maximum and equal to $\sqrt{3/4}$ of the voltage appearing across the points of the coil in line with the magnet poles.

This phase voltage will, at any time in a cycle, vary from a positive to a negative maximum. It will equal the positive maximum times the cosine of the angle between the electrical axis of the coil and the axis of the magnet poles.

Then, if θ is the mechanical position of the magnet measured from a position where the magnet pole axis is parallel to the electrical axis of phase e_a

$$e_a = E_{max.} \cos(\theta)$$
$$e_b = E_{max.} \cos(\theta - 120)$$
$$e_c = E_{max.} \cos(\theta - 240)$$

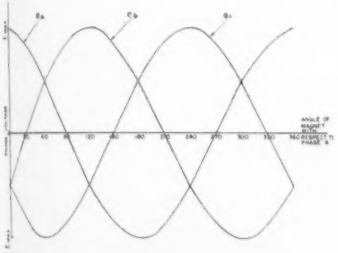

FIG. 8.

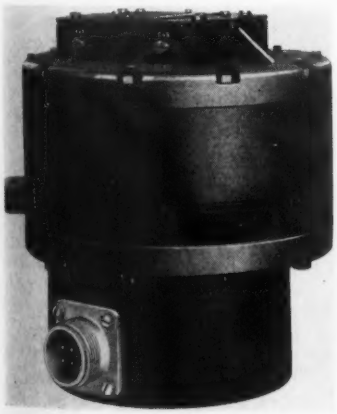

FIG. 9. Three-quarter view remote reading compass transmitter.

Flow of Second Harmonic Currents

When the magnet in the transmitter is displaced with respect to the magnet in the receiver, the second harmonic voltages at the taps of the coils are no longer equal, and currents will flow in each of the second harmonic current loops. The relationship between the values of current in each of the three loops is the familiar representation of a rotating vector by three equally spaced vectors changing in magnitude. Fundamental currents will not flow because the exciting voltage at the taps does not change during rotor displacement.

These second harmonic currents set up magnetizing forces in the displaced unit which combine with the fundamental magnetizing force. They combine in such a way that effective d.c. poles are set up which tend to attract the displaced rotor back to a position at which point circulating second harmonic currents no longer flow.

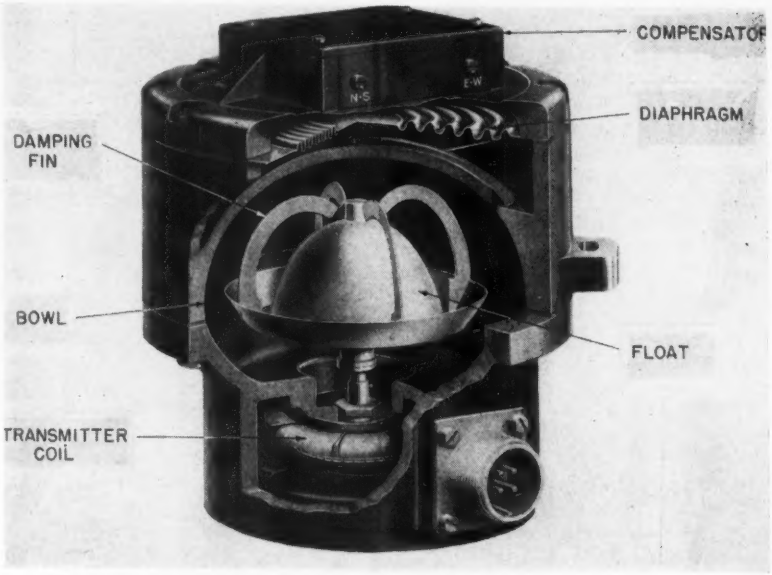

FIG. 10. Cutaway view remote reading compass transmitter.

TRANSMITTER DESIGN

The transmitter, shown in cutaway form in Fig. 10, is comprised of the compass element, the pickup or transmitter coil, the magnetic deviation corrector, and a suitable housing.

The compass element is immersed in compass fluid in a smooth-surfaced, spherical-shaped bowl, designed to reduce liquid drag and swirl. The compass element is supported by a float equipped with damping fins and pivoted on a single shock-mounted jewel. A diaphragm is used to compensate for liquid expansion and contraction.

The transmitter coil is mounted directly beneath the magnetic element and is composed of a toroidal winding on circular laminations of magnetic material.

A universal type compensator is used for magnetic deviation corrections.

The transmitter will work directly from a power source of either 26 volts, 400 cycles or 52 volts, 800 cycles. It will also operate from a 110-volt, 400-cycle airplane supply utilizing an auto transformer. For use in planes where a 400- or 800-cycle supply is not available a small 400-cycle inverter may be used as shown in Fig. 12.

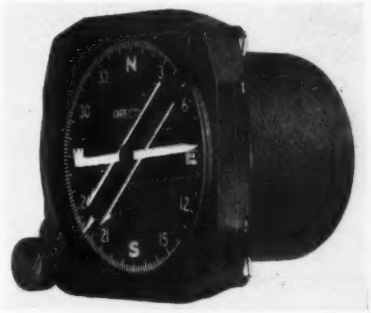

FIG. 11. Three-quarter view remote reading compass indicator.

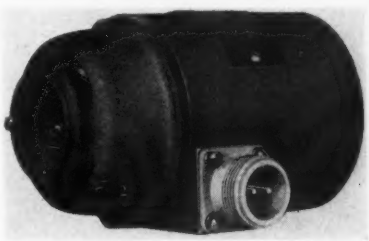

FIG. 12. Three-quarter view inverter for remote reading compass system.

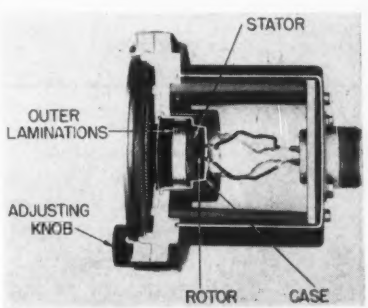

FIG. 13. Cutaway view remote reading compass indicator.

Indicator Design

The compass indicator is made up of the Magnesyn receiver unit, housing, dial, and a course reminder as shown in cutaway form in Fig. 13.

The receiver unit has a case with jewelled bearings in which the permanent magnet rotor turns. The toroidal winding of the stator is wound over a form that has inner and outer concentrically located circular laminations, the outer laminations being used as a flux return for the rotor magnet.

The dial is marked in 2° graduations with the 10° and cardinal points finished with luminous paint.

The course reminder is operated by an external adjusting knob, located at the lower front part of the instrument. The course reminder and the indicator pointer are finished with luminous paint (see Fig. 11).

The housing provides a light, rigid, dust-tight case for the component parts of the indicator. It is furnished with self-locking nuts in the mounting lugs so the indicator can be readily mounted on a panel.

Compass Characteristics

The magnetic element of the transmitter, which is, in effect, a blind compass without a readable card, has made it possible to design an element with high directive force and a fast period and yet have a minimum of overswing.

General compass performance that can be expected is as follows: accuracy — ± 2°; period—6 sec. from 30° to 5°; overswing—12° from a 90° displacement of the compass element.

The only moving parts in the compass system are the compass element in the transmitter and the rotor in the receiver.

Installation

In order to obtain reliable and accurate performance of the compass in an airplane, it is important that the transmitter be installed in a location as free as possible from magnetic interference. It is advisable to install the transmitter equidistant from all electrical wires, moving steel structures such as gun turrets, landing hooks, steel cables, tanks or other masses of magnetic materials. The less compensation that is necessary, the better the performance of the compass.

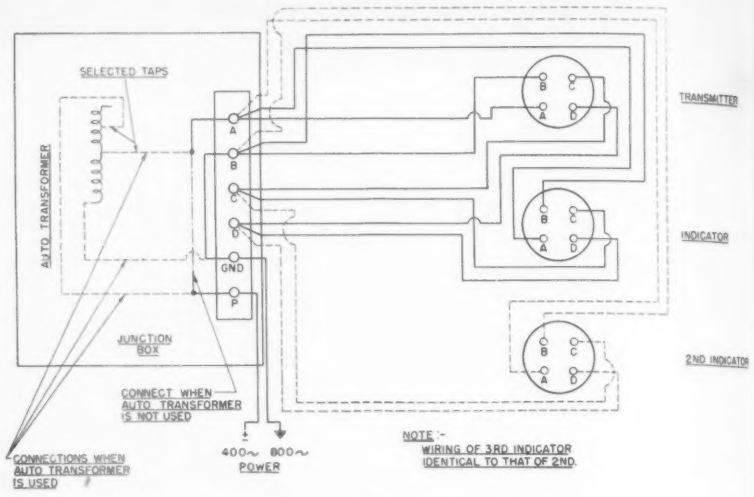

Fig. 14.

The transmitter should be mounted on a nonmagnetic platform so that the plane of the mounting lugs is horizontal in normal level flight. A plane passing through the center of the receptacle and the center of the rear mounting hole should be parallel to the fore and aft axis of the airplane, with the arrow on the top cover pointing forward. Fine adjustments of alignment can be made by rotating the transmitter unit in its mounting slots. The supporting platform should be equipped with three 1-lb. shock mounts to reduce the effect of extreme vibration and shock.

The compass indicators may be located in any convenient position best suited for observation purposes. The indicator should preferably be installed on a panel where the maximum movement of vibration does not exceed 0.010 in. between 500 and 2,500 r.p.m.

The inverter, when used as a source of 400-cycle power for the compass, should be located at least 5 ft. away from the transmitter unit and in a place where there is a reasonable amount of free air space around it for heat dissipation.

Using suitable flexible shielded cables, the units should be connected together as shown on the wiring diagram, Fig. 14.

Compensation

With the system's power on and with the airplane over a compass rose, compensation for any local magnetic deviations is made in the conventional manner by swinging the airplane over the rose and making adjustments at the cardinal points for any deviations present.

Conclusions

The advantages of this compass over the ones previously experimented with are briefly summarized below.

(a) The system is light and compact, with transmitter, indicator, and inverter weighing $2^3/_4$, $^3/_4$, and $1^1/_2$ lbs., respectively.

(b) Since there are but four conductors required between units, installation and wiring are easy.

(c) The system's flexibility permits the use of one of three compass indicators that are independent of cable length.

(d) There are no moving parts between the compass element of the transmitter and the compass indicators.

(e) Design simplicity with few parts tends toward quick assembly, low maintenance, and rapid production.

Changes of Address

To facilitate the prompt receipt of copies of the Journal and Review each month, members and subscribers are requested to give the editorial offices 30 day's notice of any change of address.

Notices should be sent directly to the Institute of the Aeronautical Sciences, 1505 RCA Bldg. West, 30 Rockefeller Plaza, New York, N. Y.

IN TIME OF WAR PREPARE FOR PEACE

In his first annual address to Congress in 1790, George Washington said, "To be prepared for war is one of the most effectual means of preserving peace."

Today, in the midst of war, his advice might well read, "In time of *war* prepare for peace." For peace, like war, has definite objectives—which should be planned in advance.

When victory brings peace, the contributions of industry no less than statesmanship, will help determine the kind of world we'll live in . . . and aircraft will play an important role.

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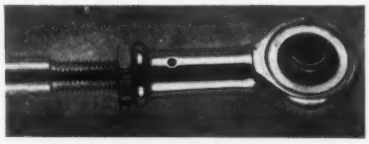
Intercoolers and Their Performance in Aircraft. S. K. Anderson and P. A. Scherer. The limitations in the design of supercharger intercoolers are discussed. The paper defines the basic independent variables involved in the performance of a heat exchanger and shows how graphs are laid out to represent the conditions that must be met and the results to be achieved. Trends in intercooler design are studied through consideration of three general types, each of which is analyzed in considerable detail. A comparison of the different types is made on the basis of effectiveness, power consumption, and weight. The field for further research is explored, and suggestions that aftercoolers should be further developed and that more attention should be given to the coolant stream exit are among those included. *Aviation*, March, 1943, pages 125, 127, 129, 333, 334, 337, 338, 8 illus.

Balloons Used Life Rafts First. In this article the writer shows that the life rafts that today are standard equipment for aircraft operating over the water are a development of rafts used during the early days of balloon racing. It is stated that the first raft, a crude affair, was built in the Goodyear Tire & Rubber Company's balloon room under the direction of J. F. Cooper, who retired after having built thousands of balloons. Modern life rafts are described. *Contact*, March, 1943, page 26, 2 illus.



The new Simmonds Prentice rod end. (*See* page 135.)

Electrical Protective Devices for Aircraft. John C. Lebens, Jr. Information on the requirements for electrical protective devices, such as fuses and circuit breakers, for use in aircraft and on the character of investigations that must be undertaken before such equipment can be installed in an airplane is given. Reasons for the failure of certain types of fuses are explained, as well as the properties of fuses that are acceptable for the work required. Similar information is given on circuit breakers and the conditions under which they must operate, together with specifications for circuit breakers capable of rendering the service necessary in aircraft. The specifications of the Underwriters' Laboratories for aircraft circuit wiring and protective devices are discussed, and tables are presented covering the sizes and capacities of wire. *Aero Digest*, March, 1943, pages 235, 237, 239, 379, 380, 382, 383, 6 illus.

Automatic Pilot Seat. S. R. Winters. The purpose, construction, and operation of a seat designed to reduce pilot's "black out" are explained. As his dive bomber abruptly changes from a downward direction to an upward plunge, the pilot is assisted into a supine position by the flexible seat. At the same time, as he releases the bomb, control of the plane passes to a gyroscopic control. A series of illustrations following a plane through a pull-out after release of bombs in vertical flight shows the seat operation in its sequence of adjustments. *Flying*, April, 1943, pages 87, 90, 2 illus.

Slotted Hinge Speeds Removal of Cargo Doors. The construction of a new slotted hinge, which facilitates the rapid removal of doors from aircraft, is explained. Invented by a Douglas Aircraft Company employee, the device eliminates loose pieces by having the pin welded to one-half of the hinge. *Aviation*, March, 1943, page 242, 3 illus.

Diesel Auxiliary Power Units for Large Aircraft. Eldon M. Wilson. The functions of auxiliary power units for aircraft are discussed. It is shown that with the increasing size of airplanes there are many advantages in providing independent sources of power for the operation of controls and for other functions instead of taking power from the main engines. The characteristics of gasoline and Diesel engines are compared, it being noted that in the matter of weight the Diesel type offsets its greater mechanical weight by the lighter weight of the fuel required. Other advantages mentioned are dependability, ease of servicing, and the reduction of fire hazard. Complete, independent

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"power packs" for this purpose are described. *Aero Digest*, March, 1943, pages 259, 398.

Designing for Aircraft Lighting. Methods for obtaining correct illumination of aircraft interiors are worked out on a scientific basis. The light intensity in lumens required and the determination of the approximate amount of light to be reflected by the surrounding elements are obtained by mathematical analysis. A series of tables lists the reflection factors of certain colors common to aircraft cabin applications in per cent of received illumination intensity; candle power, physical size, and type of base on all aircraft lamps for 12- and 24-volt systems; and rheostat sizes for dimming of instrument panel lights by the pilot. The advantages and disadvantages of fluorescent lighting are also given. *Western Flying*, March, 1943, pages 36, 78, 80, 2 illus.

Fire Protection Equipment on PAA "Clippers." The fire-extinguishing systems carried by Pan American Clippers are described briefly. Data are also given on how this equipment is inspected, tested, and overhauled. *Aviation*, March, 1943, pages 241, 370, 4 illus.

Aerodynamics

A Method for Rapid Estimation of Helicopter Performance. Quentin Wald. Several papers are available which treat the analysis of rotating wing aircraft with considerable rigor and completeness. While these treatments are satisfactory for exhaustive analyses of specific helicopters, they are exceedingly complex. Since simple methods of performance estimation are available for airplanes, it is believed that a comparable system for helicopters should prove useful for comparative performance studies, preliminary estimation of characteristics of proposed designs, and determination of the effects of small changes in design. Frequently, only limited data are available for studies of this type, making elaborate analyses impossible or undesirable. The present report proposes a system of performance estimation which, it is hoped, will fulfill the need. The method is relatively simple and rapid.

The method is based on the conception of the rotor as an actuator disc and the well-known momentum relations for an actuator disc. All of the major variables in design and operation are taken into account. Comparisons have indicated that the results obtained by this system are good approximations to the results of more elaborate analysis.

The views and opinions expressed in this section are exclusively those of the writers or publications named. They are in no case to be construed as those of the Aeronautical Engineering Review or the Institute of the Aeronautical Sciences.

In many respects this paper was suggested by Knight's paper, "General Flight Analysis of the Helicopter," but the method of approach is different and somewhat greater generality is obtained. *Journal of the Aeronautical Sciences*, April, 1943, pages 131–135, 3 illus.

A New Law for Calculating Drag. V. M. Falkner. An examination is made of some of the evidence on which the resistance law of a smooth flat plate with turbulent boundary layer is based. The writer demonstrates that a power index law for the resistance agrees with experiment quite as well as formulas involving logarithms. It is shown that the suggested new value for the coefficient of frictional resistance and the previously used law for the velocity distribution in the boundary layer can be coupled together by a revised dimensional theory connecting velocity distribution with surface friction. They have the advantage that they lead to formulas for the quantities usually required which are convenient for purposes of calculation. The dimensionally correct method of expressing the increases of resistance due to edge effects is given in an appendix, which also contains figures giving the order of these effects for turbulent flow. *Aircraft Engineering*, March, 1943, pages 65–69, 7 illus.

How to Fair Lines by Graphical Calculus. Part II. Dean Madsen. The concluding section of a two-part article presents an analysis of the method of determining offsets for noninteger stations. The basic principle is explained as the determination of a trapezoidal area, contained under the first derivative curve and between the station of unknown ordinate, adding that area, algebraically, to the known ordinate to obtain the value of the unknown ordinate. A detailed explanation of the procedure is given with the aid of graphs and formulas. The conclusion is reached that graphic calculus can be applied to any undefined curve and that the result is satisfactory for splicing purposes. Curves developed in this manner can be faired into any defined mathematical curve by plotting the first derivative of the known curve and splicing the calculus curve to it. *Aviation*, March, 1943, pages 137, 139, 338, 341, 342, 344, 347, 4 illus.

Air Cargo

Bomber-to-Freighter Conversion Unlikely. Major William M. Sheehan. In this article the writer explains why he believes it unlikely that military transport planes will be converted to commercial cargo planes after the war. He points out that with increased air activity the depletion of equipment will be greater and states that the need for postwar armed preparedness will make the flooding of the aircraft market by the surplus equipment from armed services a remote possibility. Difficulties involved in the conversion of bombers to cargo planes are set forth. Operational and cost problems are also discussed. A table of trends in air transport design is presented. *American Aviation*, March 15, 1943, pages 14, 32, 1 illus.

Background for Air Cargo. Ralph E. Oursler. Some observations on the future of air cargo. The importance of cooperation between railroads, truckers, steamship companies, and air lines is stressed, supported by statistics showing that the volume and types of cargo require different carrying agents. Among the problems of air freight commented on are cost, pickup and delivery, and loading. *Southern Flight*, March, 1943, pages 22, 28, 42, 2 illus.; "Air Cargo Facts vs. Fancy," *Western Flying*, March, 1943, pages 48, 49, 2 illus.

Cargo-by-Air Guards Life and Health for Hemisphere Production. An article describing air transport's role in the war program as revealed by the Institute of Inter-American Affairs, called the Rockefeller Committee. It tells how American air lines are transporting medical supplies, food, and other cargoes for the inter-American health and sanitation program. *Air Transportation*, March, 1943, pages 43, 44.

Ground Time . . . Spells Profit or Loss. William A. Lippman, Jr. Analyzing the costliness of "ground time" in air cargo, the writer suggests several ways of diminishing it. Among the methods he discusses are those for facilitating loading and unloading. These include (1) improvements in aircraft design, (2) raising the tail of the plane to provide a level deck, (3) belt loaders to handle cargo between ground and plane deck, and (4) improved means of cargo lashing. He also refers to changes in air freight schedules which would relieve congestion of traffic

during later afternoon and evening hours. *Aviation*, March, 1943, pages 232, 233, 380, 383, 6 illus.

Air Policy

The Logic of the Air. The problem of international postwar air policy is discussed. Under the doctrine of freedom of the air all nations would have the right to fly in one another's air, while with the doctrine of sovereignty of the air every nation would have the right to close off the air above its frontiers. Though the question of air power is regarded by the writer as indivisible from the whole international problem, in this article he treats it as a separate problem in order to avoid confusion from preconceived conventional notions of international affairs and to study the relationship of air power itself to the international problem.

With the aid of maps the writer shows why he believes a closed sky policy can only result in exclusion for America. Stating that it is in the American interest to make the international air reasonably free, an American approach to the subject is outlined. The American premise would be an international agreement on the right to fly, not everywhere, but anywhere that trade and national security justify. *Fortune*, April, 1943, pages 72–74, 188, 190, 192, 194, 2 illus.

Air Power

Air Strategy Spells Air Strength. Leonard Engel. A detailed study of two opposing doctrines of air strategy: One, the Douhet theory, follows a pattern of independent air action and is most nearly illustrated by the tactics of the Royal Air Force; the other, the Clausewitz theory, considers the airplane as an integral part of concerted land-sea-air action and is most nearly illustrated by Germany's war tactics. The influence of the two doctrines is traced in a survey of both Britain's and Germany's strategies throughout the present war. It is also shown how the doctrine advocated by Germany fits in with geopolitics, her science of conquest. The article explains the production concentration on different types of planes required for each strategy. It relates when each doctrine has been successful and when it has not. With the Battle of Britain designated as a departure from Germany's accepted strategy, reasons are given why she lost this campaign. A small portion of the discussion is devoted to indication of the extent to which American, Japanese, and Russian theories of air power follow either of the two doctrines. *Skyways*, April, 1943, pages 26, 27, 36, 37, 68, 69, 4 illus.

The American Doctrine of Air Power. Part II. Major Nathaniel F. Silsbee. The conclusion of a two-part article explaining the air-war theories upon which U.S. military aviation is based. In it the writer analyzes the functions of attack, fighter, and air supply aviation, mentioning the airplanes used for each. He also names the keymen responsible for the evolution of American air power. *Aviation*, March, 1943, pages 96, 98, 99, 379, 380, 12 illus.

The Promise of Air Power. Part I. Tom Ashley. The first of a series of articles reviewing the basic principles of American air power and how they were formulated. This installment is concerned with the creation of the GHQ Air Force in 1935 and the first goals set for the U.S. air force by its leaders. In addition to noting the development of mobility (the concentration of air strength at any point in the United States within hours was made possible), meteorology, instrument flying, aerial navigation, and team training, it recounts how specialization was applied to

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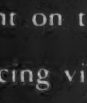
Look Ahead with 

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every phase of combat training. Scopes of operation assigned to pursuit, attack, and bombardment aviation are related. *Southern Flight*, March, 1943, pages 16, 17, 20, 33, 2 illus.

Air Transport

The Endless Possibilities for Commercial Aviation After the War. B. C. Boulton. On the basis of present trends, predictions are made with regard to future commercial aviation. The article is divided into two parts: The first traces aeronautical technical and production developments and shows how war-stimulated progress will affect peacetime aviation; the second discusses broad technical aspects of future commercial and private planes.

After reviewing the safety record of the air lines and the increase in the number of passengers and amount of mail and cargo carried by air transports, the article shows how the training of aviation personnel, the reduction of airplane production and maintenance costs, accelerated production, the trend toward standardization, and cooperation among manufacturers—all necessitated by the war—will promote the widespread use of air travel after the war. Assembly, sheet metal forming, and tooling techniques are described among recent changes in production processes which have helped to lower costs. Other factors examined are postwar competition, substitution of cheaper materials, and the use of plastics.

In the second part of the article the writer includes details on Douglas, Boeing, and Lockheed air transport planes with regard to improved safety, speed, and comfort. Taking into consideration technical and economic limitations, he conjectures on future airplane speeds and weights. *Aero Digest*, March, 1943, pages 111–113, 138, 140, 386, 388, 390, 392, 394–398, 11 illus.

From Cape to Cairo Belgian Air Transport Is Still Flying. Henri Fast. This is one of a series of articles on the air progress of other nations. The history of the development of air transport in Belgium, which, it is noted, was one of the first European countries to become air-minded, is outlined.

The rapid development of air lines is ascribed partly to conflicting interests of the great powers, which left Belgium some loopholes, but more particularly to the initiative and spirit of a few leaders. The writer explains that despite the war the Congo Sabena air line today is operating its prewar lines inside the Congo and also a number of new lines. *Air Transportation*, March, 1943, pages 14–16, 3 illus.

"Wanted"—An Air Charter. Some comments on the need for an immediate definite government policy with regard to British postwar air transport. Stressing the desirability of government leadership in bringing operators and manufacturers together, the writer takes account of certain fundamental considerations and broadly outlines suggestions for a basic air transport policy. One of the problems he covers is the question of what aircraft will be used in the interim period from the cessation of war until the time when the airplane industry will have changed over to peacetime production. His opinion is that the best solution is to design the type of aircraft that would serve with but minor modifications for both present military and postwar civil transport. *Flight*, February, 11, 1943, page 148.

Airline Information. A new monthly magazine presents detailed information on schedules, tariffs, and other pertinent data on air-line travel and transport. It covers all U.S. and Canadian air lines, U.S. foreign carriers, and all Latin-American air lines. Priority, air cargo, international travel information, and interline reservation codes are included. Among the items given are: rates of fare; time tables; air-mail and air-express information; indexes of cities in the United States, Canada, and Latin-America; Government bureaus; currency; visa and passport information; and air-line maps of Alaska, Canada, Caribbean countries, Mexico, South America, and the United States. *Universal Airline Schedules*, April, 1943.

Wings Over the Americas. The writer gives the story of the Inter-American Escadrille, which was organized seven years ago to further cooperative air development in the Western Hemisphere. Major objectives of the Escadrille are enumerated. It is explained that the Escadrille has taken over in the other American republics the activities of the Air Youth of America, which in the United States are under the National Aeronautic Association. *Air Transportation*, March, 1943, pages 38–40.

Air Transport Planning. Alan J. Cobham. This article discusses Britain's future in the air, which the writer states will depend on the creation of a great aircraft and air transport industry. It is suggested that there should be a separate Ministry of Civil Aviation because air transport has vast international interests and obligations and government concurrence on developments will be necessary. The air transport side of the industry should be recognized and a variety of operating companies established. The writer believes that today is the time to plan for the great air-route organizations of the future. *Flight*, February 25, 1943, pages 196, 197.

The President's Flight. John Murdoch. A log of President Roosevelt's flight to the Casablanca conference. The article records the routes taken, the weather encountered, the stops made, and the roster of those aboard the landplane and two flying boats that participated in the trip. *Flying*, April, 1943, pages 25, 164, 165, 167, 1 illus.

Catering in the Clouds. Frances Caswell. A study of the problem of what food to serve on Pan American Airways clippers under war conditions is described in this article. Engineers found that a change from elaborate meals to sandwiches, fruits, and beverages providing adequate nutriment would not result in a sufficient saving in weight to be worth while. Serving was simplified, however, by partially preparing beforehand nearly all the items on the menu in the flight kitchens. *Air-Age*, April, 1943 pages 26, 27, 63, 64, 3 illus.

Flight Practice and Procedure on Pan American Airways. The precautions taken by Pan American Airways to ensure the success of long flights made by its clipper ships are outlined. The writer describes the personnel requisites of ocean air transport. Marine practice and the responsibilities of the flight engineer are discussed. Research benefits that have been realized through experience with ocean flying are mentioned. Other subjects covered include the fuel factor, the flight plan, and keeping the aircraft at its most efficient speed throughout the flight. The need for further research on air transport design is emphasized. *Aircraft*, February 1943, pages 10–13, 4 illus.

British Airways. An article is presented on the development and operations of the British Overseas Airways and the Imperial Airways. The Empire route from Africa to India and beyond is referred to, as well as the Return Ferry which British Airways operates from Great Britain to Canada. The writer also describes the trans-African route, which was de-

veloped since the war started and which is considered one of the most important to the Allies. *Air Mail Magazine*, February, 1943, pages 943–958, 7 illus.; "Blazing the African Air Trail," *Western Flying*, March, 1943, page 88.

Future Aviation. Francis Gallagher. As a prelude to a discussion of future aviation the writer presents a historic outline of past aviation developments. A comparison is drawn between a transport plane of 23 years ago and one of today with particular reference to advances in operating equipment and instruments. Possible aircraft-engine developments of the future are considered. An airliner of the future which, with attendant gliders, will carry 400 passengers is visualized. *Air-Age*, April, 1943, pages 40, 41, 71, 72, 2 illus.

Airplane Descriptions

The Constellation. Hall L. Hibbard. The Vice-President and Chief Engineer of Lockheed Aircraft Corporation describes the company's recent four-engined, land-based, cargo- and passenger-carrying airplane and how he worked with Lockheed's chief research engineer and chief structures engineer in preparing the design. He relates how the idea of the airplane originated and how it differs from other aircraft of its class. Remarks are made on the wing and its flaps and how they were developed and on the power plants.

The accessibility of the engines and accessories is noted with regard to maintenance and service problems. The general arrangement of the interior is mentioned, with data on its capacity and the purposes for which it will be used, although specific figures and other detailed engineering information cannot be revealed. *Air Trails*, April, 1943, pages 16, 17, 50, 52, 4 illus.; "Lockheed's Mighty Constellation," *Commercial Aviation*, February, 1943, pages 110, 112, 114, 116, 118, 11 illus.

The Messerschmitt ME 210A1. Technical details of the Messerschmitt Me 210 A1 are revealed as obtained from captured specimens. This fighter bomber is a two-seater low-wing monoplane powered by two 1,395 hp. Daimler-Benz D.B. 601F1 engines. Maximum speed is reported to be 365 m.p.h. at 19,680 ft. with a range of about 1,500 miles at 275 m.p.h. It is stated that the Me 210 A1 discloses little advance in military airplane design except for a new type of gun mounting that can be trained to fire downward at an angle. This employs a remotely controlled, two-gun, rearward firing barbette. A sectional drawing of the plane helps to clarify the text. *The Aeroplane*, February 12, 1943, pages 194–197; 5 illus.; *Flight*, February 11, 1943, pages 143–146, 1 illus.; "Germany's Newest Fighter Bomber," M. W. Bourdon, *Automotive and Aviation Industries*, April 1, 1943, pages 34–37, 7 illus.; "Newest Messerschmitt," *Air Tech.*, April, 1943, pages 48–51, 8 illus.

The North American A-36, a dive-bomber version of the P-51 Mustang. (*See* page 131.)

British Reports on German Aeroplanes. VIII. The Focke-Wulf FW 190. A detailed report on the design and construction of the Focke-Wulf FW 190, issued by the British Ministry of Aircraft Production, is presented. Sections of the article cover the structure of this aircraft, the engine installation, aerodynamic features, armament, and electrical installations. *Aircraft Engineering*, March, 1943, pages 76–81, 12 illus.

M. I. P. Smyk. J. P. A detailed description of the M.I.P. Smyk, one of the late light-plane prototypes designed and built by students of the Technical University of Warsaw. A low-power single-seater of wooden construction, this plane was intended to facilitate the training of glider pilots as power pilots. It was designed to achieve the best possible performance by reducing to a minimum the parasite drag while using an engine of really low power. Among the features marked are its differential gearing and peculiarities of its retractable undercarriage. *Flight*, February 11, 1943, pages 152–154, 6 illus.

Transparent Fighter. It is suggested that the rapid development of plastics may begin to tinge with reality the fantastic tales of transparent aircraft, almost invisible to the enemy, which have appeared in fiction. An aviation artist's conception of such a plane is presented. *Air Trails*, April, 1943, pages 14, 15, 3 illus.

Two Miles Types. The Miles M.18 and M.28 are described in detail, with performance figures and specification data given for both. Designed as an intermediate trainer or communications aircraft, the M.28 is powered by the Gipsy Major Series III, IIIS, IIA, or the Cirrus Major 150 engines. Maximum speeds quoted for this plane vary with different engines from 155 to 176 m.p.h.; cruising range is placed at about 700 miles, cruising speed from 140 to 166 m.p.h., and stalling speed at about 40 m.p.h.

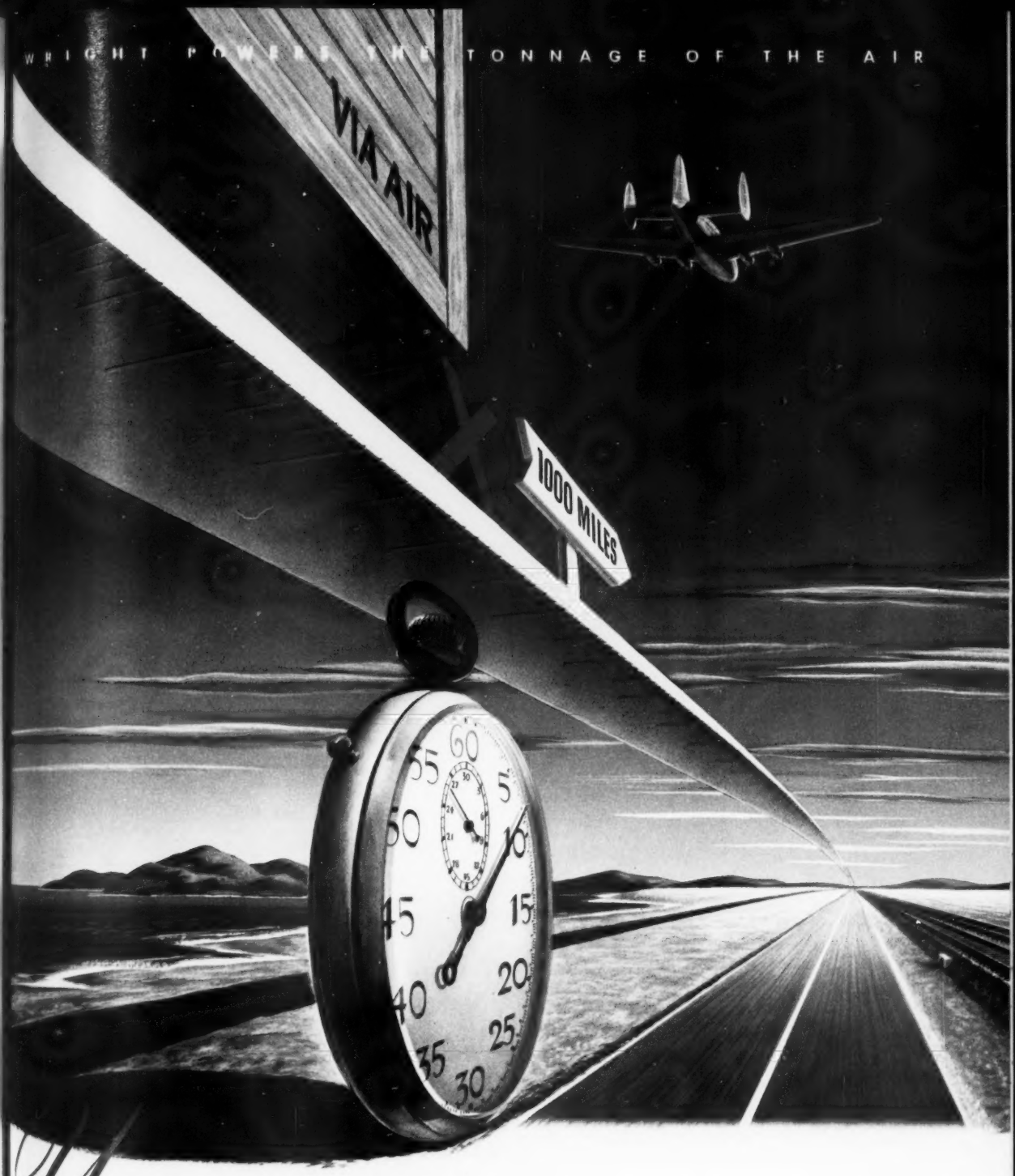
The M.18 is a two-seater trainer fitted with Gipsy Major Series III engine. Similar in most structural characteristics to the Miles Magister, speeds are: maximum, 145 m.p.h.; cruising, 125 m.p.h.; stalling, 39 m.p.h.; and landing, 45 m.p.h. As an outstanding feature the article notes the five-piece flap gear. *Flight*, February 4, 1943, pages 115–118, 10 illus.; "The Miles M-18," "The Miles M-28," *The Aeroplane*, February 5, 1943, pages 17, 18, 6 illus.

Airports

Engineering an Airport. Curtis Fuller. An investigation of the engineering principles that control the construction of an airport. Emphasis is placed upon the fact that the principal considerations—soil, rain, and load stresses—are the same as those that influenced road building. The discussion covers three main components of runway design: drainage, base stabilization, and surface construction. *Flying*, April, 1943, pages 44, 45, 150, 152, 2 illus.

Armament

Power-Operated Gun Turrets. The general principles of the Boulton Paul electro-hydraulic system of turret operations are outlined, its main advantages are cited, and the features associated with the various types of turrets developed by this company are examined in detail. Among those discussed are the generator and its action, hydraulic motor, gun-fire interrupter, "shadow patterns," ammunition systems, and mounting ring. Compactness, simplicity, and sensitivity of control are said to characterize these gun turrets. Interpretation of the text is aided by diagrammatic drawings. *Flight*, February 4, 1943, pages 122–127, 12 illus.; "The Electro-Hydraulic Turret," *The Aero-*



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BOOTS AIRCRAFT NUT CORPORATION ★ GENERAL OFFICES, NEW CANAAN, CONNECTICUT

plane, February 5, 1943, pages 153–156, 8 illus.; "Boulton Paul Gun Turret Mechanism," M. W. Bourdon, *Automotive and Aviation Industries*, April 1, 1943, pages 28–33, 11 illus.

Bombardeo Aéreo. Estudio de la Forma, Centrado y Dimensión de los Estabilizadores en las Bombas de Aviación. (Aerial Bombing. Study of the Form, Centering, and Dimensions of the Stabilizing Fins of Aerial Bombs.) Alexjandro Sirvent Dargent. In studying the form of a bomb, two problems that are diametrically opposed to one another present themselves—namely, the penetration of the air by the bomb and its stability while in the air. With these problems in mind the writer presents a mathematical investigation of the maximum efficiency of an aerial bomb, giving special consideration to its stabilising fins. *Revista de Aeronautica*, November, 1942, pages 367–369, 8 illus.

Aircraft Gun Control Systems. H. G. Conway. This article on various control methods for firing aircraft guns is particularly concerned with pneumatic operation and the need for selector units in planes employing mixed types of guns. Mechanical, electric, and hydraulic controls are noted, but emphasis is placed upon the simplicity and lightness of pneumatic systems. With the French designated as pioneers in the development of pneumatic gun systems incorporating selectors, features of several French systems are described. Diagrams illustrate both the selector units and pneumatic operation. *Flight*, February 11, 1943, pages 149–151, 9 illus.

Bearings

Bearings of Laminated Phenolic Materials. Reference is made to work carried out in Germany on bearings made of synthetic resins and fillers (laminated phenolic materials), and it is stated that such bearings are being used for industrial applications where rubbing speeds are low. It is explained that the conventional form of sleeve bearings of laminated phenolic material have proved unsuitable where high thermal and mechanical stresses must be sustained. Nonmetallic materials have an extremely low heat conductivity, and precautions that must be taken to get rid of heat are enumerated. Procedures necessary to enable nonmetallic bearings safely to carry loads equal to those carried by metallic bearings are described. Journals are wrapped with thin strips of fabric impregnated with synthetic resin. It is stated that these "armored journals" can carry loads exceeding the maximum permissible loads for tin bearings. Tests of such bearings as applied to aircraft and automobile engines are described. *Automotive and Aviation Industries*, April 1, 1943, pages 45, 80, 1 illus.

Blind Flying

Ridin' the Range. Robert N. Buck. Before discussing the practice of instrument flying, the writer emphasizes that the pilot should select a certain altitude and maintain it and that proficiency in instrument flying requires extensive practice, enabling the pilot to do his work with ease and without nervous strain. He then gives a detailed description of how an airplane should be flown on the radio range. To clarify the explanation, an imaginary flight is followed with the aid of diagrams. Instructions are given for making corrections and checking the course. A succeeding installment will discuss "hitting the cone," and landing. *Air Facts*, April, 1943, pages 28–36, 4 illus.

Business and Finance

Latin America . . . the Industry's Land of Promise. Walter R. Douglass. A survey of aviation developments in Brazil, Argentina, Mexico, and Peru and a consideration of Latin America as a potential aviation market. A type of plane suitable for the topography of South America and lending itself to air transportation is suggested. It is stated that indicated requirements of Latin America for bases, shops, repair facilities, equipment warehouses, parts, and accessories make it a natural market for excess production of the United States postwar aircraft industry. *Aero Digest*, March, 1943, pages 118, 120, 400–403, 8 illus.

Regulatory Stability for Air Transport Industry. H. L. Federman. An analytic report of the trend in airmail and passenger-fare rates. In a discussion of recent mail-rate decisions by the C.A.B., it is stated that the majority opinion of the Board appears to have disavowed any intention to establish a rate of mail compensation which would limit earnings to a fixed rate of return on investment. Standardization of rates is indicated by a report that, with the exception of Colonial Airlines, the same rate was established as the future mail compensation for every carrier. With regard to passenger fares, the downward trend of rates is traced, placing the current charge at an average of about five cents per mile. *Aviation*, March, 1943, pages 239, 347, 348.

Civil Air Defense

Answer to Air Power. Allen Raymond. Recent improvements in anti-aircraft guns and the methods of using them are credited with greatly increasing the defensive power of nations. It is stated that great progress in the development of electrical and mechanical aids to accurate gunnery has been made in the last 18 months and that the industrial systems of all the combatant nations are turning out these new developments in large quantities. Mobile anti-aircraft operations are described. The future effect of increased defensive strength on air supremacy is discussed. *Popular Science*, May, 1943, pages 66–72, 214, 20 illus.

Civil Aviation

New Working Chart for War and Peace. A chart showing the organization activities of the National Aeronautic Association is presented. With the aid of an accompanying article an understanding of the purpose of the various divisions is provided. *National Aeronautics*, March, 1943, pages 26, 27.

The Air and Shipping. Condemning the British government's past policy with regard to civil aviation, the writer proposes several reform measures. He suggests that civil aviation be conducted by private enterprise, subsidized and supervised by the government. In contrast to what he states was the practice before the war, he stresses the importance of granting like consideration and equal opportunity to all competent interests. A further point to his proposal is that four or five groups of private enterprises be chosen to control British commercial air lines over different areas of the world. *Flight*, February 4, 1943, page 121.

Civil Aviation, The War, and The PEACE. Col. Edgar S. Gorrell. The President of the Air Transport Association of America traces the rapid development of the civil aviation industry since the enactment of the Civil Aeronautics Act of 1938. He describes how civilian transport aviation has placed its entire resources at the disposal of the Government and discusses the problems and future possibilities of postwar expansion. *National Aeronautics*, March, 1943, pages 20, 44, 1 illus.

The Unsung CAP. Esther H. Forbes. The important part the Civil Air Patrol is playing in the prosecution of the war is portrayed and the C.A.P. training program is briefly outlined. *U.S. Air Services*, March, 1943, pages 18, 19, 50, 2 illus.

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Air Travel—1950. D. C. Greenwood. The civil development of flying after the war is discussed and future possibilities are considered. Sections of the article deal with passenger service, air-mail service, aircraft design, flight refueling, flying boats, and international transport. *Aeronautics*, March, 1943, pages 56, 57.

Respectfully Submitted. John R. Peters. Remarks are made on the military regulations controlling civilian flying near the defense areas along the nation's coastlines under prevailing war conditions. Experiences with the authorities controlling the air in the vicinities of these zones are reviewed. Comments are made on what are regarded as injustices imposed upon civilian aircraft and on so-called violations of the regulations by certain members of the military establishments. *Air Facts* April, 1943, pages 37–40.

Control Equipment

The "Bristol" Hydraulic System. The type of hydraulic system for the remote control of aircraft components developed by the Bristol Aeroplane Company is described. It is explained that in the development of the Bristol system the objectives were reliability; light weight; flexibility of control; a quick, smooth, reverse motion; a useful "slip" for overload or obstruction; and a convenient location of transmission members. Advantages inherent in the hydraulic principle of operation are summarized. The development of the Bristol system is discussed under sections covering hydraulic pumps, the layout of the system, the multiple control valve, the pilot's control panel, the double relief and nonreturn valve, transfer valves, emergency service controls, and the by-pass relief valves. Also described are the double hydraulic lock that prevents any movement of the bomb doors unless hydraulic pressure is applied and the choke valve to prevent too rapid movement of the flaps. *The Engineer*, March 19, 1943, pages 237–239, 8 illus.

Design

I Prefer Flying Boats. Glenn L. Martin. The President of The Glenn L. Martin Company analyzes the advantages of flying boats compared with land-based planes. He claims that they are a more efficient and safer means of transport; that they eliminate the necessity for vulnerable airports, possess a larger average disposable-load proportion than large landplanes, and offer a shorter critical range of travel; and that they present greater flexibility in landing and refueling possibilities. He answers common objections to flying boats with respect to operations under icy conditions, comparable speeds, costs and weights, size limitation, passenger rates and operation costs, safety, and comfort. The Martin Mars is given as an example of a successful flying boat.

The article also indicates some changes in aircraft design predicted by the writer. Among these are that he sees great value in the towplane-glider combination. *Skyways*, April, 1943, pages 12–15, 40, 21 illus.

The irregularity of receipt of publications from abroad necessitates the review of articles in issues several months late. This is done to provide readers with information regarding foreign technical progress as soon as the issues are available in the United States.

Lofting Problems of Streamline Bodies. Part II. Carter M. Hartley and Roy A. Liming. The purpose of the eleventh installment of this article is to establish in greater detail the features of the conic lofting techniques, particularly with respect to mathematical applications that have been described in preceding articles of the series. An effort is made to give a full practical explanation of the most commonly used graphic methods of constructing the general conic, the development of the basic formula by means of which curve equations are expressed, classification of curves for convenience in calculation, and the complete development of an actual curve application through a special series of breakdown calculation charts.

It is shown that all the basic curves required for the design of the fuselage, including the profile plane and front views, may be classified as one type for purposes of calculation, and through a system of charts the required data may be quickly established for purposes of engineering, lofting, and tooling. *Aero Digest*, March, 1943, pages 185, 190, 192, 380, 382, 3 illus.

Need for Design Simplicity Stressed. E. J. Foley. The writer suggests that the breakdown illustrations of aircraft published today which make the airplane look so simple may have a good influence on future design. He recommends that manufacturers strive to attain design simplicity and accessibility equal to that of the illustrations. The need for greater simplification in the design of transport planes of the future is emphasized. *American Aviation*, April 1, 1943, page 48, 1 illus.

The Effect of Compromise on the Design of Aircraft. Contaire. The writer points out the objections to compromise methods followed in the design of aircraft. He describes compromises that have been made in fighter models and considers the possibility of building a greater number of fighter types each suited to a particular service. *Aeronautics*, March, 1943, pages 42, 43.

Enemy Undercarriages. From information and drawings supplied by the Technical Department of Rubery Owen Messier Ltd., details are given about a number of enemy undercarriage units. In summation it is stated that these units display no startling developments and on the whole appear to be inferior to British equipment. Data refers to the Junkers Ju 88, Heinkel He 111 Tailwheel, Messerschmitt Me 109 Tailwheel, Fiat C.R. 42, and Dewoitine D 520. *The Aeroplane*, February 19, 1943, pages 216, 217, 10 illus.

Engines

Harmonic Coefficients of Engine Torque Curves. Frederic P. Porter. The torque curves of engines are the result of the combined effects of gas pressures and the forces due to the inertia and weight of the moving parts. In this article tables for the harmonic coefficients of the torque due to inertia and weight effects are presented for a wide range of crank-to-connecting rod ratios. Families of indicator diagrams, representative of various types of engines, are shown, and tables of the harmonic coefficients of the resulting torques are given. The types of engines considered are two-cycle gas, semi-Diesel, single-acting Diesel, double-acting Diesel, two-shaft opposed-piston Diesel, and four-cycle gasoline and Diesel engines. *Journal of Applied Mechanics*, March, 1943, pages A-33–A-48, 24 illus.

Horsepower for Victory. George G. Devereux. The development of aircraft engines from the time of the Wright brothers to the present is traced. How the horsepower of engines has been increased and the weight reduced by many design refinements is described. The writer discusses the development of radial engines and the progress made in the design of liquid-cooled engines. He comments on the record of the Rolls Royce Merlin and compares the per-

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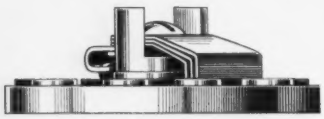

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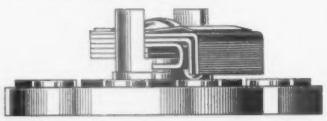

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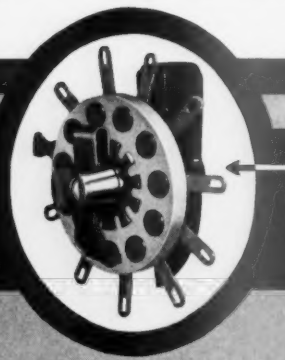

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formance of this engine and the Allison with that of the Daimler-Benz 603. Problems of engine cooling are summarized. Production angles also are considered. *Air Tech*, April, 1943, pages 22–27, 68, 6 illus.

Methods of Stress Determination in Engine Parts. Charles Lipson. A comparison is drawn between older methods of structural and machine design using empirical formulas reinforced by factors of safety and newer methods involving accurate stress measurements, developed because of the increasing importance of weight-saving requirements. Four methods of experimental stress analysis used in the Chrysler laboratories are described—namely, photoelasticity, Stresscoat, extensometers, and electric strain gauges. The writer explains how these are applied in given engine problems involving the evolution of a new design, the determination of the cause of failure, and a comparison between various designs. The two principal means of procedure followed with the new methods—static tests, using simulated service loading, and dynamic tests, under actual service conditions—are discussed and compared. *S.A.E. Journal*, April, 1943, pages 105–124 (Transactions), 60 illus.

An Evaluation of Engine Types. Everard M. Lester. A comparison is made of the various types of current American aircraft engines in volume production. Air-cooled radial types as produced mainly by Wright Aeronautical and Pratt & Whitney, liquid-cooled in-line engines produced by Allison, and air-cooled in-line types as produced by the Ranger Division of Fairchild are considered. Basing his discussion on the major points of engine manufacture, design, and performance, the writer presents an evaluation of which type appears the most favorable and which appears the least favorable with regard to each point. The factors that he subjects to a detailed comparative analysis are inherent problems, fabrication and other costs, accessibility, installed weight, installed drag, exhaust jet propulsion, maximum pressure, average cylinder pressures, and manufacturing cost. *Aero Digest*, March, 1943, pages 364, 374, 417, 419, 421–424.

Flight Technique

Drift. Wolfgang Langewiesche. Effects of wind upon an airplane in flight are discussed in nontechnical language and numerous erroneous assumptions are corrected. Examples of drift are given and instructions are presented on how to counteract drift, how to fly with the wind, and the ef-

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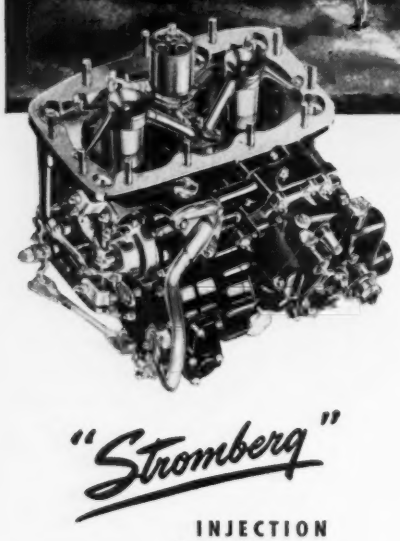

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fects of wind on turns. Numerous questions asked by students are answered, these serving to summarize the information contained in the article. *Air Facts*, April, 1943, pages 41, 42, 44–63, 6 illus.

Twin Engine Flying Is Easy. Capt. Gerald B. Gard. The writer tells how student pilots at the Columbus Army Flying School are taught the flying characteristics of the twin-engined airplane when one engine fails and the procedure to be followed in order to maintain safe single-engine flight. The ten points that the instruction covers are outlined in the article. These are: air speed, directional control, pitch, throttles, bad engine, good engine, trim, pumps, gas, and trouble search. *The Sportsman Pilot*, March, 1943, pages 14, 15, 6 illus.

Gliding and Soaring

Glider Train. Elvon L. Howe. An account of a long-distance multiple tow experiment, said to be the first recorded one in America. The trip was taken by a Waco towing two gliders at an average speed of 85 m.p.h., covered 1,000 air-line miles, and afforded the basis for several conclusions with regard to passenger and freight transport by the multiple-glider method. One of these was the discarding of the "V" formation because of excessive drag on the towplane; a straight-line position for the gliders about 40 ft. above the Waco proved most satisfactory.

Among the more obvious improvements that this experiment indicated as necessary for the greater practicability of glider trains are larger fuel capacity in the towplane, cabin heaters in the gliders, intercommunication, a redesigned cooling system for the towplane engine, built-in rear-view mirrors, and automatic reels for drawing towropes back inside the power craft to eliminate the time-consuming process of handling ropes on the ground. The article also presents a forecast of design development in glider trains by the man who organized the experiment. *Flying*, April, 1943, pages 40–42, 144, 5 illus.

War Gliders. N. D. Ryder. Martial applications of the glider, both as troop carrier and trainer, are discussed at some length. The glider's role in "vertical envelopment" tactics and the type of expendable glider needed for these operations are explained. Examining current developments in the United States and Great Britain, the article includes details on British, American, and German gliders in production. *Flight*, February 18, 1943, pages 171–174, 9 illus.

High-Altitude Flying

High-altitude Flight. W. Nichols. Confined mainly to the commercial aviation phase of the subject, this is the first installment of an article dealing with the problems of high-altitude flight. Structural, physical, and aerodynamic factors are reviewed to determine at what distances flights at various altitudes would be justified from the standpoint of time economy. The meteorologic factor is examined at somewhat greater length and a large portion of the article is devoted to consideration of pressurized cabins. Problems connected with power plants are discussed under the following headings: engine ratings, fuel, airscrews, and supercharging the engine. *Flight*, February 18, 1943, pages 180–183, 8 illus.

High-Altitude Flight. W. Nichols. Part 2 of this series of articles continues a discussion of flight at high altitudes, with particular attention to the oxygen supply for pilots, and problems connected with the subject of high-pressure cabins. The effects of height on the human body are examined. Sections of the article deal with pressure cabin interchangeability and pressure cabins for military reconnaisance. Some German designs of pressure cabin are described. *Flight*, February 25, 1943, pages 206–209, 12 illus.

Icing

The Icing of Aircraft. Rac. An article describing how ice forms on aircraft discusses methods of eliminating the trouble. The advantages and disadvantages of mechanical and chemical methods of ice elimination are investigated. *Aeronautics*, March, 1943, pages 60, 61, 2 illus.

Instruments

Inside the Compass. An article is presented on the various types of compasses used in aircraft. The writer tells how they operate and describes the faults they may develop and how to remedy them. *Air Tech*, April, 1943, pages 54, 55, 62, 6 illus.

Landing Gear

What Makes the Wheels Go Up. David Vine. The general design and principle of operation of hydraulic landing gears are outlined. The article explains how they work, why liquid is used in the system instead of air, and the way the pilot operates them. *Canadian Air Cadet*, March, 1943, pages 7, 24, 3 illus.

Lubrication

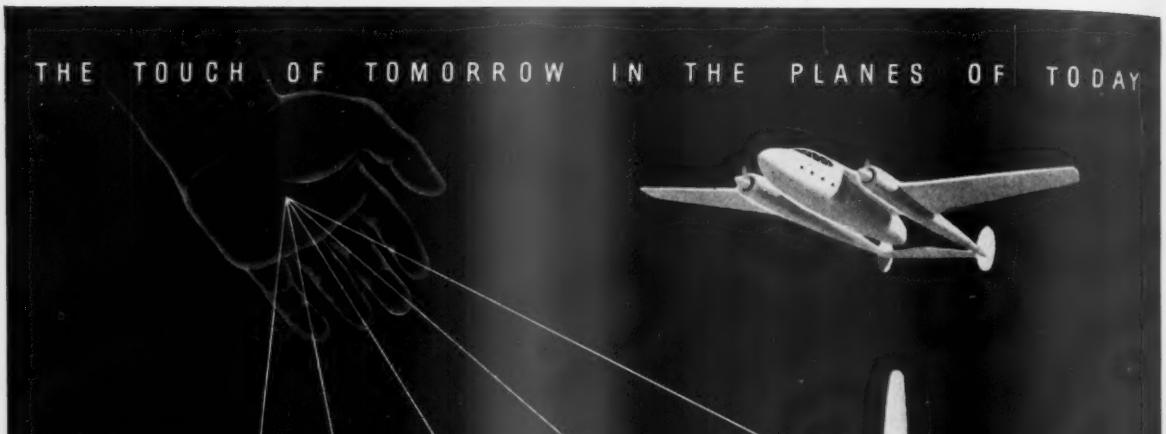
Piston-Ring Scuffing as a Criterion of Oil Performance. George H. Keller. The writer states that the only satisfactory evidence for comparing the lubricating qualities of different oils is the condition of engine parts after testing under standardized pressure. The detailed setup for such engine tests is described. In the tests conducted all the pertinent operating variables except cooling conditions and oil supply were held constant. A Waukesha Cooperative Universal engine fitted with a Wright Cyclone cylinder was used for the tests. The test procedure is outlined. Figures are given on the increased power output, reduction in specific weight, and reduction in specific fuel consumption obtained as a result of the combined research of metallurgists, petroleum chemists, and engine designers during the past ten years. *S.A.E. Journal*, April, 1943, pages 125–129 (Transactions), 8 illus.

Re-Refining of Aircraft-Engine Oils. Gilbert K. Brower. Information and data are presented on the re-refining of aircraft-engine lubricating oils, based on twelve years of experience with the use of such oils in the field of air transport. The distinction between the reclamation process and the re-refining process is explained. A review of service experience, cost figures, and several refining processes is included. *S.A.E. Journal*, April, 1943, pages 130–138 (Transactions), 2 illus.

Maintenance

Wheel Maintenance at American Airlines. Ray Miller. The procedure of checking and overhauling wheels at American Airlines is detailed. Particulars on various kinds of equipment developed by America's maintenance men for reducing expenses and increasing efficiency are given. *Aviation*, March, 1943, pages 245–247, 380, 9 illus.

Cargo Planes Shod Faster. How the Line Maintenance Foreman of American Airlines developed a method of removing the tires of heavy cargo planes which is saving many man-hours is described in this article. It is explained that the heat generated when a heavy plane makes a landing causes the tires to become vulcanized to the rims. The development of a



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special device which greatly facilitates tire removal is outlined. *Air Tech*, April, 1943, pages 17–20, 10 illus.

Flying Starts on the Ground. Jerome Jacobs. The writer describes how fighting aircraft of the Army Air Forces are kept in condition and outlines the great strides in maintenance procedure which have been made. *Air-Age*, April, 1943, pages 36, 37, 59, 62, 4 illus.

Handling the Halifax. A. C. H. Purthrey. The maintenance procedure followed by the R.A.F. in keeping the Handley Page Halifax in flying condition is described in detail. *Air Tech*, April, 1943, pages 30–32, 5 illus.

Total Maintenance by Mfrs. Proposed. E. J. Foley. The writer considers a suggestion that manufacturers should assume full administrative responsibility for the maintenance of air-line transport planes, this being an extension of a principle outlined by him in a previous article. He states that, with the contemplated future expansion of air transport, it may be possible to justify the capital investment required of the aircraft manufacturer to establish one or more large overhaul bases at strategic locations. *American Aviation*, March 15, 1943, page 56, 1 illus.

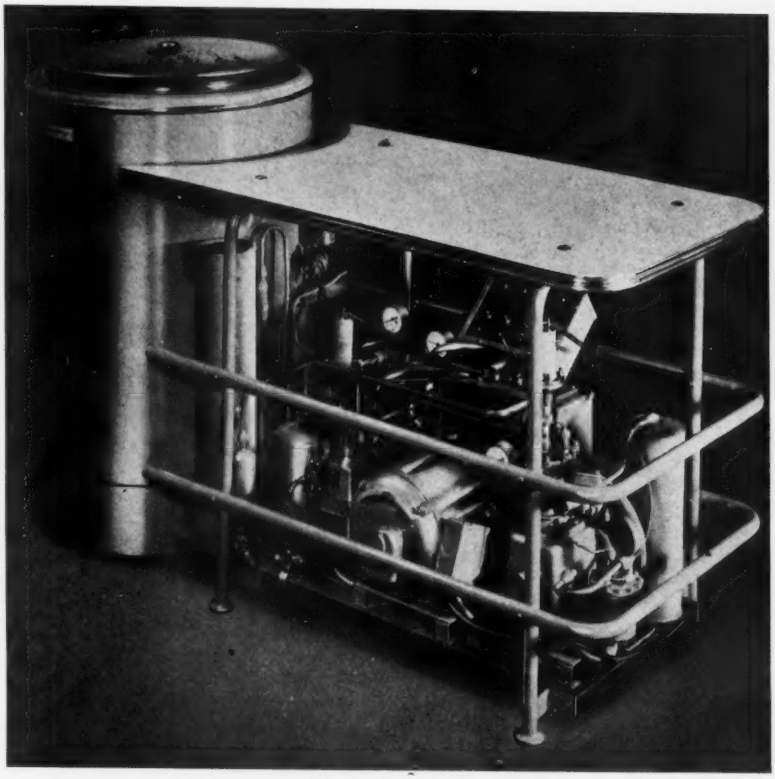
Airplane Engine Overhaul Line. The assembly-line technique developed by the Chicago and Southern Airlines for the mass overhaul of trainer engines is described. One feature of the repair shop is a portable engine test stand that is stated to save approximately one man-hour of work per engine. *Air Tech*, April, 1943, pages 42, 43, 7 illus.

SE Keeps 'Em Flying. Robert McLarren. An account of the duties of the Squadron Engineer, who has the responsibility of keeping flying equipment in first-class condition and ready in quantity and state of preparedness to meet any exigencies a situation may demand. How the Squadron Commander, the Supply Officer and the Squadron Engineer form a team that keeps a squadron of five to 25 airplanes in condition is described. Maintenance operations are discussed in considerable detail. *Model Airplane News*, April, 1943, pages 6, 7, 42, 44, 45, 8 illus.

Servicing Accumulators. J. Perrin. This article describes the servicing of the accumulators used to provide power for aircraft hydraulic systems. *Air Tech*, April, 1943, pages 44, 45, 62, 4 illus.

Management

Some Observations on the Industry's Post-War Planning. Sidney Siggia. The writer calls to the attention of aircraft manufacturers some fields of peacetime enterprise to which they can convert their experience, excess facilities, and personnel. Sheet-metal businesses—such as air conditioning, metal furniture, etc.—wood, and plastics are among those suggested. *Aero Digest*, March, 1943, pages 368, 405, 406.



Motor Products Corporation Model D-70 Deepfreeze industrial chilling unit. (*See* page 119.)

Manufacturing Equipment

Maintenance Steps to Prolong Instrument Life. Theodore A. Cohen. Procedures for the care of industrial instruments are outlined and causes of instrument failure are listed and methods of preventing them described. Among the problems discussed are those in connection with improper location and installation of instruments, prolonged vibration, shock, dirt infiltration, excessive temperatures, corrosion, excessive moistures, and exposure to strong magnetic fields. The article details particularly the care necessary for pressure instruments, pyrometers, and thermocouples. *Aero Digest*, March, 1943, pages 244, 248, 251, 7 illus.

Materials

American Airlines' Materials Laboratory Gets Paying Results. An account of the testing and research activities of the American Airlines' Materials Laboratory. In addition to outlining the laboratory's typical procedure, the article includes data on several of its developments. One of these is the Refinoil process, which is said to effect an oil saving of up to 25 per cent of the purchased total; another is an operation for redistilling cleaning fluid, which is claimed to salvage 98 per cent of the amount used. *Aviation*, March, 1943, pages 235, 237, 380, 4 illus.

Medicine

Vision, Hearing, and Aeronautical Design. Leon D. Carson, Walter R. Miles, and S. S. Stevens. The relationship of the design characteristics of combat airplanes to the functions of the vision and hearing of the crew men are studied. Factors involved in the placing of pilots, gunners, observers, and others with reference to visibility of objects on the ground and the moving targets provided by enemy aircraft are analyzed.

Vision inside the aircraft is discussed, as well as the connection between vision and air sickness, in which it is stated that hearing suffers more than sight as a result of the environmental stress of flying. The noises created by the engine and the propeller are shown to have unfavorable

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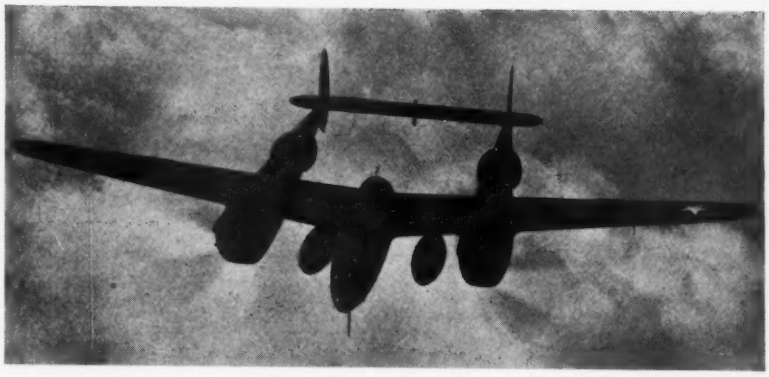
effects upon the hearing functions, resulting in temporary deafness and interfering materially with the duties of the men, such as receiving messages and instructions from outside sources and from other crew members. The statement is made that the most important practical effect of airplane noise is the masking of communications. Three remedies are suggested for overcoming the difficulties caused by airplane noises. It is the conclusion of the writers that the problems raised by intense ambient noises are serious but not insoluble. The use of microphones, earphones, and other acoustic devices is recommended. For improved vision it is suggested that the structure of the airplane be modified, as far as aerodynamic considerations will permit, in order to provide maximum visibility. *Journal of the Aeronautical Sciences*, April, 1943, pages 127–130.

The School of Aviation Medicine—and the War. Brig. Gen. Eugen G. Reinartz. A paper delivered before the 50th Annual Convention of the Association of Military Surgeons by the Commandant of the School of Aviation Medicine, Randolph Field, Tex., presents a comprehensive report of the school's purpose, its activities, and achievements. Listing the requirements for a flight surgeon and defining some of the problems with which he must cope, the writer also briefly outlines the history, organization, and curriculum of the School of Aviation Medicine. He then indicates the present trends of teaching at the School by a separate consideration of each department. Those he details are: aviation medicine, under which comes cardiology, gastroenterology, and medicine in the field (the latter is subdivided into military medicine, military preventive medicine, equipment in the field, and evacuation of wounded by air); neuropsychiatry, ophthalmology, and otorhinolaryngology; and psychology. *The Military Surgeon*, March, 1943, pages 233–242.

Pilot's Health Commandments. Alma Heflin McCormick. This article deals with the most common causes for rejection of candidate pilots by examining flight surgeons. It indicates those defects that are correctable and suggests methods of preventing physical and psychologic disorders in pilots who are already qualified. Among the disabilities discussed are: emotion and fatigue, with their consequent effects on blood pressure, heart action, and digestion; eye defects, ear, nose and throat ailments; defective teeth; abnormalities of the abdomen, pelvis, or genitourinary system; acne; underweight, overweight, and insufficient height. *Flying*, April, 1943, pages 51, 52, 154, 156, 2 illus.



The Lockheed Lightning equipped with two droppable fuel tanks. Each tank carries 165 gal. of gasoline. The two tanks reduce the speed of the plane only 4 per cent at top speed. (*See* page 128.)

Effect of Exposure to Anoxia of a Moderate Degree on the Excretion of Ascorbic Acid in the Urine. L. R. Krasno, A. C. Ivy, A. J. Atkinson, and W. B. Johnson. A preliminary report of tests conducted by the writers is presented. Test methods are outlined and the results of the experiments are tabulated and described. Experiments were carried out with human male subjects and also with guinea pigs. The subjects were placed in altitude chambers and exposed to varying degrees of anoxia for certain periods of time. It was found that exposure of the subjects to an altitude pressure corresponding to 18,000 ft. for one hour daily, or every second or third day, disturbed the metabolism of vitamin C. The immediate effects of exposure appeared to be vitamin retention. Repeated exposures appeared to affect its utilization or synthesis. It is noted that the results of these exploratory experiments raise more questions than they answer. *War Medicine*, March, 1943, pages 256–266.

What It Takes to Make a Good War Pilot. This is the second of a series of articles on the medical selection of pilots. The effects of altitude, centrifugal force, acceleration, and undue retardation are considered. A chart showing the effects of various altitudes on the individual is presented. *Aircraft*, February, 1943, pages 28, 30.

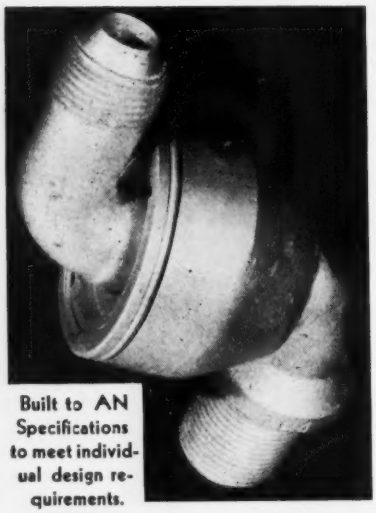
How to Prevent Air Sickness. G. R. Wendt. A medical doctor advises how to prevent and combat nausea caused by air travel. He presents the psychologic reasons for air sickness and lists fourteen detailed rules for instructors to follow for the prevention of symptoms in their students.

It is stated that both prevention and cure of motion sickness depend on repetitively successful trips made without nausea. To accomplish this it is suggested that short trips be made first, and only in fine weather; that no acrobatic maneuvers be tried with inexperienced pilots; and that, until tolerance is established, the novice should not be permitted to fly when upset by hangovers, fatigue, constipation, unwise eating, or minor illness. *Flying*, April, 1943, pages 58–60, 142, 143 3 illus.

Effects of Increased Flying Time on Aviation Instructors. Capt. John E. Dougherty. An investigation of the effects of increased flying time on instructors of the Army Air Forces. The study was conducted with a particular effort to ascertain objective and subjective symptoms and signs of fatigue. The methods used are outlined. Subjective changes were determined by questioning a pilot regarding his general health and by studying subjective symptoms. Objective changes were determined by means of the Schneider Test and by testing for heterophoria. Tables clarify the method and present the summarized results. *War Medicine*, March, 1943, pages 297–302, 1 illus.

Food to Fly On. Hannah Lees. Feminine mess officers supervise the preparation and serving of food for the R.C.A.F. This article relates how the innovation was made, why it was necessary, and the improvements it has effected in the diet of air force personnel. Expert dietitians, these feminine mess officers plan their menus from standard rations. However, the food served under their supervision is not only claimed to be far more palatable but also far greater in nutritive value than similar ration meals the men received before.

Data are also included on the nutrition laboratories, cooking schools, and test kitchens, which have been set up to supplement the dietitians' work. *Collier's*, March 20, 1943, pages 13, 74, 75, 2 illus.



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Military Aviation

Airborne Engineers. Brig. Gen. Stuart C. Godfrey. A brigadier general's report on the activities of the aviation engineers in North Africa. He describes how they build and camouflage airfields for advance actions under conditions of danger and haste. Notes are included on the training and background of these airborne engineers, many of whom come from the regular Army Engineers division and receive instruction in airdrome requirements. *Skyways*, April, 1943, pages 16–18, 67, 8 illus.

Eaker Explains Strategy of Round-the-Clock Bombing of Germany. A report is given on Major General Eaker's attitude regarding round-the-clock bombing of Germany. It is explained that, while the maximum destructive effort against the enemy can be realized at night, 24-hour bombing forces Germany to maintain three air-raid patrol shifts instead of two. Daylight bombing makes it necessary for the enemy to maintain a large force of day fighters which otherwise would be free to operate on the Russian front. *U.S. Air Services*, March, 1943, page 54.

The Airplane as a Battle Weapon. Major Nathaniel F. Silsbee. This article is devoted largely to the subject of attack aviation. Reference is made to the two main functions of air power—cooperation with the ground forces and independent action. The importance of the cooperating air force is emphasized, it being stated that the best way to assist troops is by disrupting the supply lines of the opponents, which calls for attack aviation using light or attack bombers. Design requirements of the attack bomber which present a difficult problem for the engineer are outlined. Particular attention is called to the Douglas A-20 Havoc (R.A.F. Boston III), which is a versatile plane that has been used by the R.A.F. as a day fighter, night fighter, attack bomber fighter, and patrol bomber. Reference also is made to the efficiency of the Bristol Beaufighter for similar service. *Air-Age*, April, 1943, pages 6, 7, 74, 3 illus.

Battle Log of the Liberator. Eddie Piersol. A review of the B-24's combat record. The log of highlights in the Liberator's war activities traces its service from August 8, 1942, to January 12, 1943, and gives an idea of the many fronts on which this bomber has fought. *Western Flying*, March, 1943, pages 34, 55, 72, 1 illus.

Deadly Attacker. Leslie Bryce. After giving a brief description of the Curtiss A-25 dive bomber, which is an Army version of the SB2C-1, the

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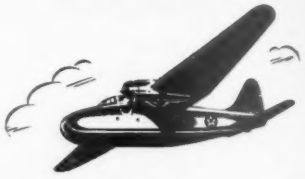

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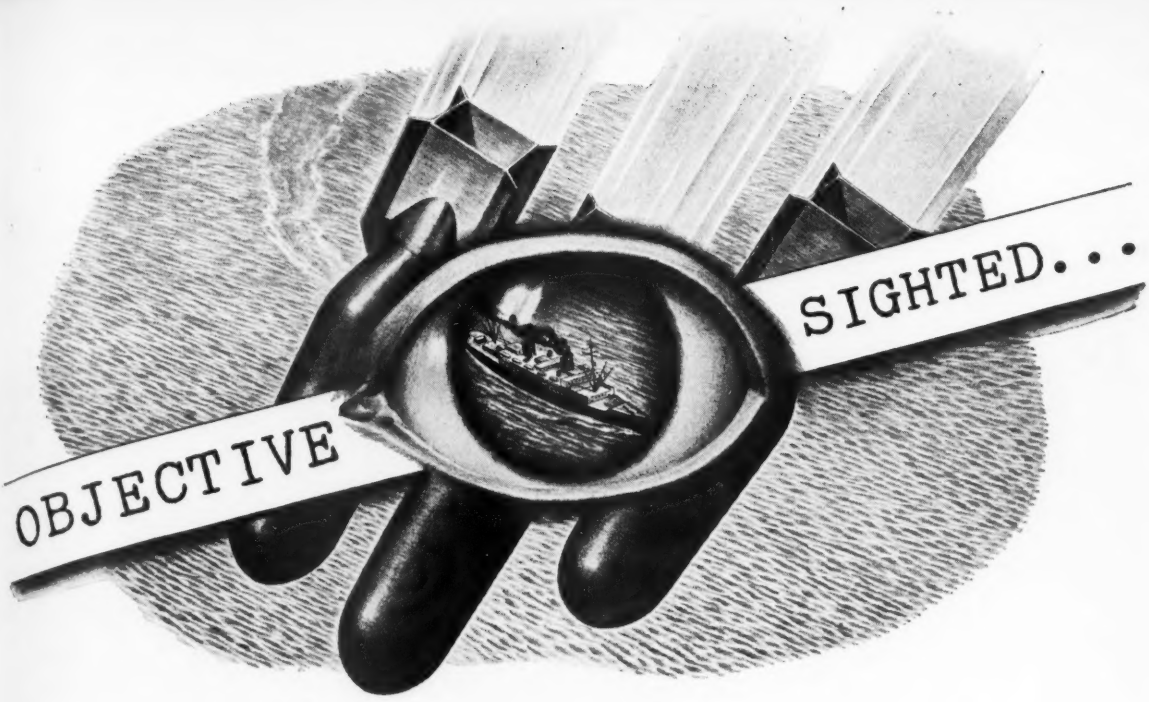

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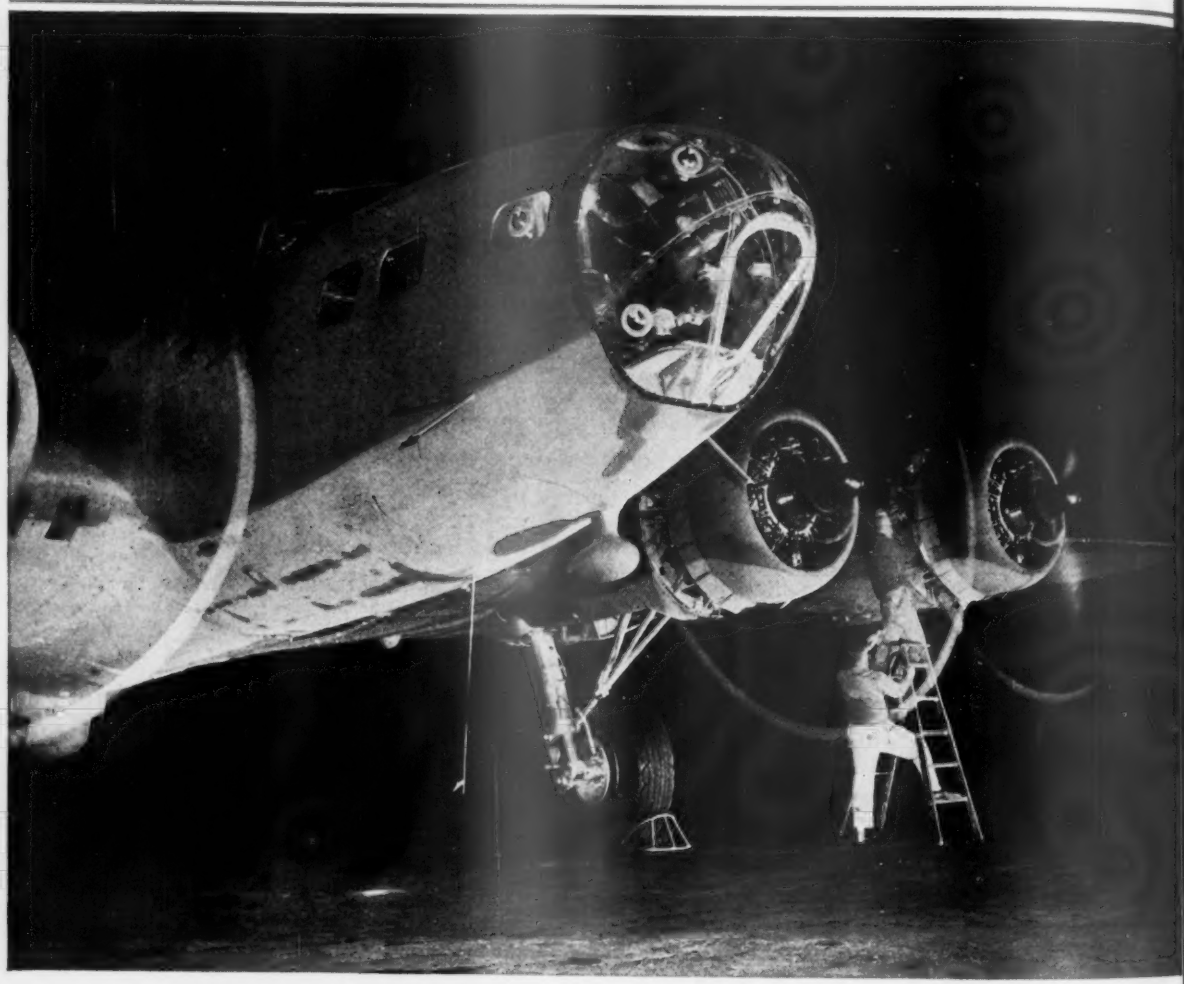

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writer traces the development of dive bombing and describes some earlier types of aircraft used for dive-bombing operations. *Airlanes*, March, 1943, pages 10–11, 19, 6 illus.

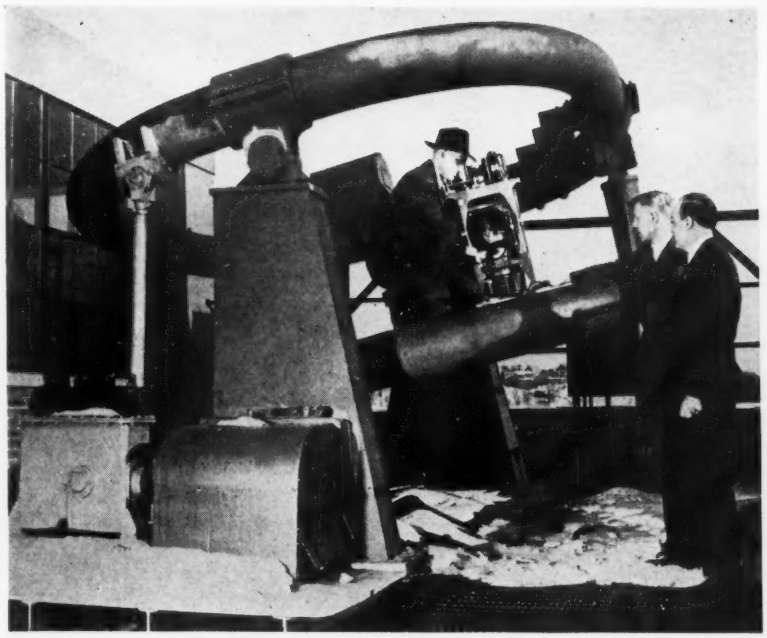
Africa as an Air Base. Capt. Norman Macmillan. The importance of Africa in the present phase of the war is discussed, particular attention being given to its value as an air base for the Allied Nations. Transport problems, the submarine danger, communication systems, and air support are also considered. Africa's potentialities as a training ground for air-borne divisions are examined. *Aeronautics*, March, 1943, pages 28–31, 1 illus.

The Army Expects an Air Raid. Henry J. Taylor. The possibilities and probability of a German air raid on the United States are visioned. Reporting that American Army authorities are convinced the Nazis will make such an attack, the writer explains its psychologic value, from the German point of view, in both their own country and the United States. It is urged that the American people defeat the purpose of these attacks if they do come by refusing to yield to hysteria. *American Mercury*, April, 1943, pages 470–473.

Naval Aviation

Will Aircraft Beat the U-Boat? John A. Ward. The writer is of the opinion that Germany will soon launch an unprecedented submarine campaign in the Atlantic which will be coordinated with new methods of aerial attack at sea. He believes that the aerial attack program will be carried out by newly developed long-range, high-altitude, multiengined aerial battleships, and he points out that current Allied patrol craft and carrier planes will be unable to combat this type of airplane. His discussion covers the probable number of U-boats which will participate in the campaign, the section of the Atlantic where attacks are most likely to take place, the most plausible time of the day for them to take place, and the type of task force the Allies can use to upset German submarine strategy. *Aero Digest*, March, 1943, pages 114–117, 10 illus.

Slingshot Planes. William S. Friedman. An outline of the development of shipboard observation planes from the time a workable catapult was perfected, telling how observation planes today are being used to guide American warships. Modern types of naval observation planes are described. Particular reference is made to the Vought-Sikorsky Kingfisher and the Curtiss Seagull.



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Popular Science, May, 1943, pages 60–63, 10 illus.

El Avión Torpedero en el Ataque (The Torpedo Plane in Attack Position). Guillermo Carrero Carre. Ballistic and mathematical data are presented on the operation of the torpedo plane when attacking. The subjects include: calculation and determination of the aiming angle, construction of the launching circle, general rules on releasing a torpedo, calculation of the course and speed of the enemy craft, methods of attack and their comparison, simultaneous attack of several torpedo planes, and day and night attacks on naval bases. *Revista de Aeronautica*, November, 1942, pages 325–332, 13 illus.

Big Boats. William Herbert Randall. The hardships experienced by the Navy's flying-boat crew men and advances in recent years in the design of naval patrol planes are described. The twin-engined Martin Mariner and Consolidated Catalina, which are termed the present workhorses of the fleet, and the four-engined Coronado patrol boat, which is used only for extensive missions, are referred to. *Air-Age*, April, 1943, pages 42–44, 69–71, 4 illus.

El Avión Torpedero en el Ataque (The Torpedo Plane During the Attack). Guillermo Carrero Carre. The second and final installment of this article covers the reaction of the air defense of the ships to be attacked and of the active protection provided by escorting vessels. The protection offered by the battleship and the tactical use of the torpedo plane in a sea battle during daytime are discussed. A comparison is drawn between a destroyer and a torpedo plane on the basis of both day and night attacks. Comments are made on the development of the torpedo plane and its use in the present war. *Revista de Aeronautica*, December, 1942, pages 405–409, 3 illus.

Paints

Salvaging Paint Overspray. S. Donald Perlman. An article on the recovery of critical and strategic materials from wasted paint, as suggested by an exhibit of the Industrial Salvage Branch of the War Production Board, presented in cooperation with the Chicago Section of the American Chemical Society. In addition to advising the proper method of collecting "overspray," it defines the conditions under which reclamation is economically feasible. The importance of such salvage is demonstrated by estimated quantities of the various paint ingredients which can be saved, amounting to a total of about 50,000,000 lbs. per year.

Types of procedures for reclaiming the collected overspray are classified into three groups—one adapted to lacquers, another to oil base and straight alkyd compositions, and the third for urea formaldehyde finishes. *Southern Flight*, March, 1943, pages 40, 42, 1 illus.; "Recovery of Paint Overspray," *Western Flying*, March, 1943, pages 62, 84, 1 illus.

Personalities

Leaders of the Luftwaffe—XXII. H. J. A. W. The military career of Walther Von Axthelm—Lieutenant-General, Commander of the Flak Korps attached to the Fourth Air Fleet—is outlined. Because of Von Axthelm's identification with the "Flak" arm of the German air force, the article includes a discussion of how German antiaircraft artillery has been extended to encompass anti-ground target activities. During the Spanish War, Von Axthelm was charged with investigating the tactical aspect of using antiaircraft guns in a dual capacity.

Closely associated with the Hitler, Göring, and the Nazi party, Von Axthelm is said to be unpopular with his men. This is blamed on his ruthless methods, rigid discipline, and biting criticism. *The Aeroplane*, February 5, 1943, page 165, 1 illus.

Leaders of the Luftwaffe—XXIII. H. J. A. W. Biographic data supplement this character sketch of Martin Harlinghausen, Colonel, Chief of Staff of the 10 Fleiger Korps. A naval airman before he was transferred to the Luftwaffe, Harlinghausen is reported to be a daring pilot, associated mainly with air action against shipping, and decorated several times for his exploits. The writer brings in the the fact that Germany has suffered because of her shortsightedness in not coordinating her offensive against shipping with air and sea raiders and not developing specific long-range airplanes for commerce raiding. Harlinghausen shares the appraisal of being energetic and venomous but lacking vision. It is stated that he is harsh, callous, and universally hated by his subordinates. Although he is friendly with the Nazi chiefs, he has no political inclinations and bears no loyalty to the party. *The Aeroplane*, February 12, 1943, page 182, 1 illus.

Leaders of the Luftwaffe—XXIV. H. J. A. W. This is a study of one of the best-known, most efficient, and most unpopular Luftwaffe Staff Officers—Guenther Korten. As chief of staff to the commander of the Fourth Air Fleet (and, for a period, to the commander of the Third Air Fleet), he is described as the "brains behind the throne." He has been active in the planning of operations against Austria, Poland, the Balkans and Crete, Great Britain, and Russia. Korten is also credited with being responsible for the successful organization of the Fourth Air Fleet, composed of homogeneous units but mixed squadrons of Austrians and Germans. A staunch Nazi, he is reported to be

arrogant, domineering, and ruthless . . . . disliked by his brother officers and feared by his subordinates. *The Aeroplane*, February 19, 1943, page 211, 1 illus.

Leaders of the Luftwaffe—XXV. H. J. A. W. Major-Gen. Hans Hermann Ernst Seidemann is characterized in this installment. Originally an infantryman, Seidemann was trained in the illegal Luftwaffe of the Weimar Republic and is best known for his exploits as a peacetime, international racing pilot. During this period of his life, when his "sporting" activities were paid for by the German government, he is supposed to have gained information about the countries he visited. The article, however, derides his acceptance in Germany as an authority on Great Britain. Seidemann's war career is said to be entirely undistinguished, although he has served as Chief of Staff to Richthofen and to either Keller or Kesselring. With regard to his politics, no clear delineation is made, but it is accepted that he is not too unfavorably disposed toward the Nazis. *The Aeroplane*, February 26, 1943, page 241, 1 illus.

Patronato Juan de la Cierva (The Juan de la Cierva Foundation). Fernando de la Puente. This article relates that on the sixth anniversary of the death of Juan de la Cierva Codorniu Spain desires to emphasize that she has not forgotten her illustrious son. Among many other memorials is the Juan de la Cierva Foundation, which is now under the supervision of the Superior Council for Scientific Research. It is stated that the periodical *Si*, in an issue dedicated to the activities of this Council, informs its readers that it intends to publish from time to time little-known scientific data selected from the collection of the Juan de la Cierva Foundation in memory of this autogiro pioneer. *Revista de la Aeronautica*, December, 1942, pages 459–461, 6 illus.

Personnel

Building Winning Spirit Into Grumann Aircraft. Esther H. Forbes. An article on the high morale among workers of the Grumann Aircraft Engineering Corporation and some of the reasons for it. The following are contributory factors examined: the fact that 95 per cent of the personnel are native to the region in which the plants are located, extracurricular activities, methods of obtaining personnel, training schools, and nursery schools for children of women employees. Vice-President L. A. Swirbul is credited with sponsoring the employer-employee relations that facilitate production. *Aviation*, March, 1943, pages 100, 101, 374, 377, 379, 3 illus.

Keeping Them Working. Sidney Swirsky. This articles tells how aircraft companies are meeting some of the problems involved in the occupational turnover of workers at war plants. It discusses the principles upon which the training of job instructors are based. Motivations of patriotism and opportunity, as well as increased wages and individual recognition, are considered in methods for deriving the greatest potential value from the man-power supply. *Western Flying*, March, 1943, pages 42, 43, 82, 2 illus.

Photography

Mapping with Multiplex Aeroprojectors. John Bell. A detailed explanation of how maps are made from air from photographs by means of Zeiss multiplex aeroprojectors. Employed by the Chattanooga office of the United States Geological Survey for Tennessee Valley surveys, this mapping method is said not only to offer the best means of instruction in the use of stereoscopic plotting instruments but also to lend itself to steady production because of the possibility of subdividing the work. Preliminary photography, preparation of the diapositive, construction and operation of the multiplex aeroprojector are described. Mapping procedure is unfolded under three heads: (a) map sheet preparation, (b) orientation of the projectors, (c) the actual mapping. *The Aeroplane*, February 26, 1943, pages 242, 243, 4 illus.

Combat Camera. William Stull. Details are presented on the new combat camera, used by the U.S. Navy. In exterior form it resembles a machine gun. Lightness, stability, simplicity of operation, and facility in handling are among the advantages claimed for this new photographic equipment. Information is included on the electrical power system of the camera, its lenses, finder, and focusing control. *Flying*, April, 1943, page 98, 2 illus.

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Plastics and Plywood

New War Planes for the United Nations. Predicting that by the end of 1943 the United States aircraft industry will lead all others in dollar-volume production, the article outlines the development of plywood in aircraft construction. Production methods used in the manufacture of warplanes are discussed. Information on the construction of the Mosquito, which is called the first large, heavy bomber built from plywood, and on the Caravan, first cargo plane to be constructed of that material, is presented. The manufacture of the Yankee Doodle trainer and the Beaufort torpedo bomber is also described. *Modern Plastics*, March, 1943, pages 61–69, 152, 154, 29 illus.

Use of Glue in Aircraft Construction. J. T. Stephan. This article deals with the proper application of glue as a bonding agent for plywood in aircraft construction. After discussing the nature of plywood, the importance of proper stock, and protection-coated veneers, the writer examines glues for bag molding, requirements for good bonds, and causes for bond failure. He then details the effects of aging and explains why each portion of the plane assembly fabricated from plywood must be considered a separate gluing problem. *Aviation*, March, 1943, pages 132, 133, 311, 313, 315, 319, 320, 10 illus.

Canada's Plastics Industry in Wartime. Hiram McCann. Wartime activities in Canada's plastics industry are described in some detail. The changes brought about by the war are outlined. The writer tells how the Empire Air Training Program necessitated the building of training planes in Canada and explains that this brought into being a wood aircraft industry that is still expanding. *Modern Plastics*, March, 1943, pages 76, 77, 154, 5 illus.

Douglas Fir Plywood for Aircraft. N. S. Perkins. Specifications are given for the various grades of plywood made from Douglas fir which are suitable for use in the construction of aircraft. Methods of cutting the raw material from the fir log are described and the different grades are defined. The method of preparation of the lumber is also outlined. It is stated that progress has been made in reducing the costs of producing and in standardizing the material. Numerous improvements in the techniques of handling plywood and plastics are summarized and mention is made of the results achieved by the Aircraft War Production Council. The article concludes with a discussion of the broad technical aspects of airplanes for the air lines and private planes of the future. *Aero Digest*, March, 1943, pages 260, 384, 386, 388, 390, 392, 394–398, 2 illus.

Electroplating Masks. R. R. Bradshaw. Methods for preventing metal from creeping into areas which must not be plated during electroplating operations are discussed. It is explained that older methods of masking metal proved time-consuming when large quantities of aircraft parts required chrome plating. The advantages of injection molded Saran masks are described. Saran is defined as a thermoplastic resin that has opened a new field in plastic operations by solving masking problems. *Modern Plastics*, March, 1943, pages 78, 79, 136, 5 illus.

Strength Properties of Plexiglas. Part II. W. F. Bartoe. The second part of this two-part article deals with tensile strength and flexural strength of Plexiglas. The method of calculating the tensile strength of a Navy Aeronautical Specification specimen is given, and the steps taken in the preparation of the specimen for the tests are described. The results are summarized under the headings of temperature, thickness, shape, age and preconditioning, rate of straining, and prestretching. Charts are reproduced showing the data obtained. Calculations and tests for flexural strength are presented in a similar manner. *Aviation*, March, 1943, pages 140, 143, 145, 147, 359, 11 illus.

Lumarith safety hat and safety goggles protect this worker from flying particles. These goggles fit over all types of eyeglasses and have replaceable eyepieces in case of damage.

Heatronic Molding. V. E. Meharg. An account is given of a new technique for the rapid molding of thermosetting plastics. The process was developed as a result of long research on the application of electronics to the molding of thermosetting materials. The writer describes the development of heatronic molding, which is stated to make possible larger molds and reduced molding pressures. *Modern Plastics*, March, 1943, pages 87–90, 11 illus.

Advances in Plastics During 1942. G. M. Kline. Developments in the field of plastics during 1942 are reviewed and some statistics on the growth of the industry are quoted. The development of a thermosetting transparent resin especially adapted to low-pressure molding and more resistant to scratching is referred to. Improvements in the formulation of molding compounds with various fillers and plastic binders are mentioned. The rapid strides made during 1942 in the system of molding thermosetting plastics are discussed. Other sections of the article cover plastic applications, properties, testing, and specifications. *Mechanical Engineering*, April, 1943, pages 245–247, 260.

Paper Laminates for Molding. Harold J. Luth. This article describes research work directed toward the substitution of paper laminated plastics for aluminum in the manufacture of certain aircraft parts, which was started in 1942 by the Brunswick-Balke-Collender Company. Data obtained from an investigation of the effects of temperature on phenolic laminates are presented. It was found that at low temperatures the tensile and compression strength improved and impact values deteriorated only slightly. Sheets molded of this material preserved their physical values throughout the structure. Molding problems connected with the substitution are discussed. The construction of flat panel stock from Brunsalloy and the development of Brunsalloy ACBO3, which has improved physical properties and a high loading factor, are described. Data on the physical properties of this material are presented and the application of Brunsalloy to the manufacture of tubes is outlined. *Modern Plastics*, March, 1943, pages 91, 138, 140, 1 illus.

Correct Repair of Transparent Sections. Bruce MacIntosh. Methods of field patching and cleaning airplane parts made of Plexiglas, Lucite, or Lumarith are suggested. It is stated that these have been proved by application on the fighting fronts. The procedure of repairing combat

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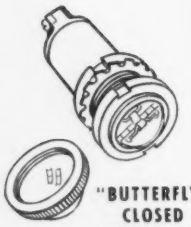

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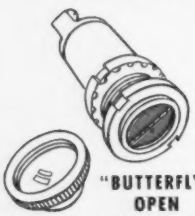

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damage is divided into two major items, bullet holes and cracks. *Aviation*, March, 1943, page 248, 9 illus.

Plastics Applied to Airplane Structures. Charles F. Marschner. The extension of the use of plastics in basic aircraft construction is discussed. The need for a carefully planned research and development program is emphasized. Possible applications of plastics to aircraft are enumerated and reasons that have prevented more extensive use of plastics are given. Information on the mechanical properties of different classes of plastics is furnished. *The Draftsman*, March, 1943, pages 11, 12, 31, 32, 1 illus.

Production

Producing the B-25 Bomber. Robert E. Dawe. A description of the flexible production lines on which the North American Mitchell is built. Economy of space and increased production are shown to result from this flexibility. The author gives details on the fabrication breakdown, the overhead conveyors, the separate center section line, joining main subassemblies, the overhead turn table, and the drag line conveyor in the final assembly lines. In addition to a profusion of photographs, the article includes a schematic diagram of the B-25 assembly arrangement. *Aviation*, March, 1943, pages 106–111, 18 illus.

Nitric-Hydrofluoric Bath for Removing Welding Flux from Aluminum Alloy Parts. Paul M. Craig. The removal of welding flux from aluminum-alloy parts by the nitric-hydrofluoric method, which is used because of the difficulties encountered with mechanical methods, is described. The proper procedure to follow with this process is outlined and information is given on the equipment required. *Automotive and Aviation Industries*, March 1, 1943, pages 19, 53, 1 illus.

The Influence of Women on Aircraft Production Methods. W. Gerard Tuttle. This article covers job simplifications and changes in production methods instituted by Vultee Aircraft to facilitate the employment of women. It examines the modifications in methods necessitated by women's physiologic, psychologic, industrial experience, and legal limitations and also designates certain industrial operations in which women excel. Instances are given of work changes to fit female labor which have resulted in increased efficiency and economy. Among the devices described as developed for this purpose are: a pneumatic drill press feed, trunnion mountings for jigs, a hydraulically actuated bench vise with pedal control, and a combination bucking bar and rivet hammer. *Aero Digest*, March, 1943, pages 142, 143, 199, 3 illus.

To increase the versatility of standard Towmotor Corporation (Cleveland) lift trucks, a scoop can be interchanged with standard forks for handling bulk materials. The scoop is available in capacities from 8 to 25 cu.ft.

Cutting Zinc Alloy Dies for Salvage. A method for zinc conservation is suggested in a letter written by the chief tool designer of Brewster Aeronautical Corporation. This consists of cutting oversized zinc dies, by means of a large blade used in a hydraulic press, to a size small enough for melting at the aircraft plant. A sketch illustrates the suggested tool. *Aviation*, March, 1943, page 134, 1 illus.

Autos to Aircraft. L. C. Goad. An analysis of the production differences between automobiles and aircraft by a General Motors executive who explains why quantity production of airplanes on a numerical parity with prewar automobile output is not possible. Together with the production practices it influences, the greater fluidity of design required for airplanes is a major factor in the differences. Another factor noted is the limited opportunity for production short cuts by arbitrary modifications of established designs.

Although the primary purpose of the article is to explain why quantity production results in automobile factories cannot be duplicated in aircraft plants, the writer concludes with a positive approach. He praises the contributions of technique and procedure to airplane building which have been made by the automotive industry. *Flying*, April, 1943, pages 26–29, 152, 153, 7 illus.

What it Takes to Get Giant Planes Into Production. Harry Woodhead. The president of the Consolidated Vultee Aircraft Corporation describes the task of creating a new airplane model. Reference is made to a 400-passenger airplane that Consolidated has been working on for many months. It is estimated that it will take two years to carry this plane from design to production. The time it took to bring the Liberator to the point of mass production is given, and the many production steps necessary in the creation of a large aircraft are traced. *Automotive and Aviation Industries*, March 1, 1943, pages 9, 50, 51, 1 illus.

Murray Fabricates Aircraft Surfaces on Moving Assembly Lines. Franklin M. Reck. The application of automotive production techniques to aircraft is illustrated by an account of the methods by which the Murray Corporation of America builds wings for the Thunderbolt. Wherever possible Murray has adapted the practice of subdividing the job into small assemblies, specializing its labor, and making a maximum number of installations in subassembly. One of the production features particularized by the article is the "merry-go-round" conveyer line for final assembly. Some details are included also on the company's work in manufacturing parts for the Liberator and outer wings, wing tips, and nacelles for the Flying Fortress. *Aero Digest*, March, 1943, pages 207, 215, 3 illus.

Production Planned 18 Months Ahead: Result: All Deliveries on Schedule. J. W. Hennen. Production control methods used in one section of the Field Division of Vultee's Southern California plant are described. The article tells how plane output is kept on schedule by the use of multiple copies of schedule cards made by the Ditto method, photographic copies of records, and readily available schedule boards kept constantly up to date. A production control chart of the Vultee Field Division accompanies the article. *Wings*, March, 1943, page 389–394, 8 illus.

The Properties of Rubber as Used in Metal Drawing and Pressing. L. J. Brown. In this article on the use of rubber in forming metal sheet the writer concentrates on the rubber aspects of the subject rather than on the metal side of the job. However, there are some references to the mechanical side. The article is offered to provide some new lines of

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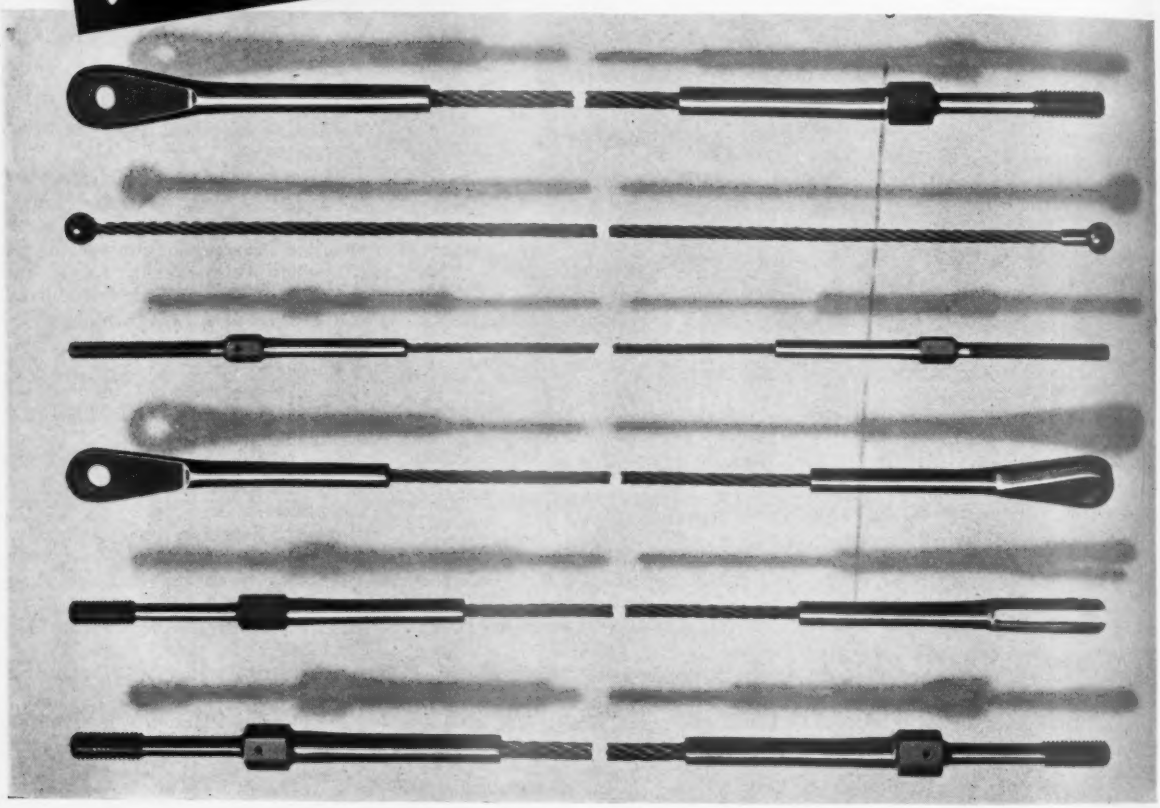

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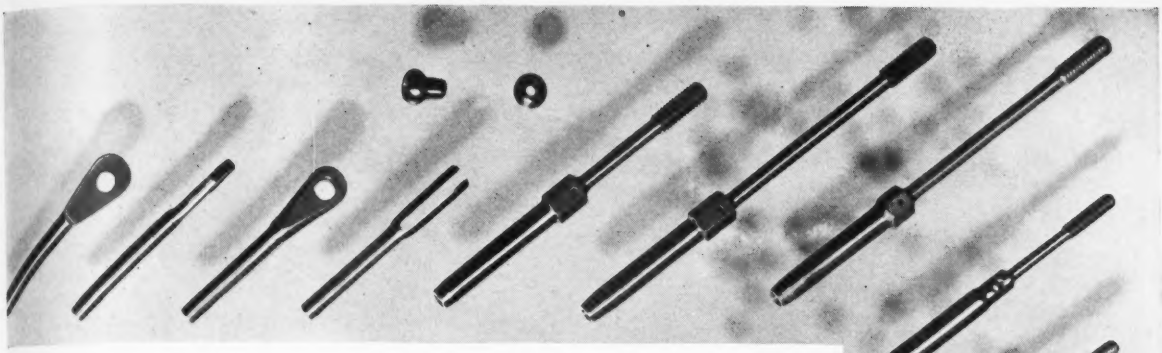

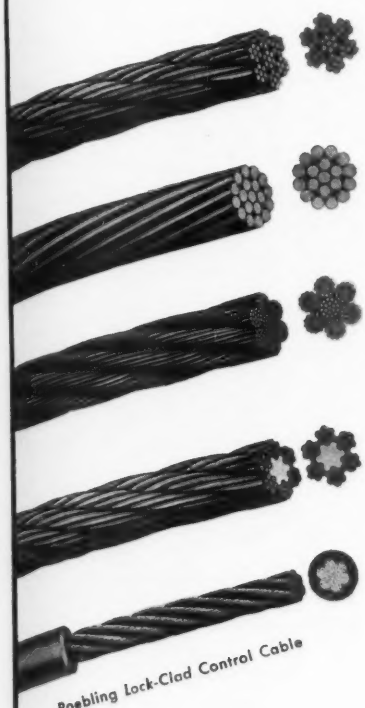

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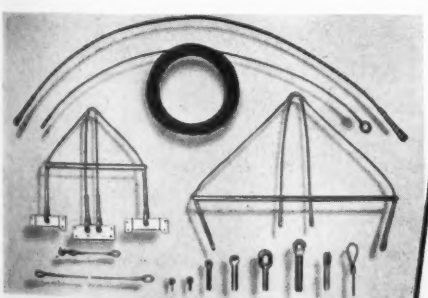

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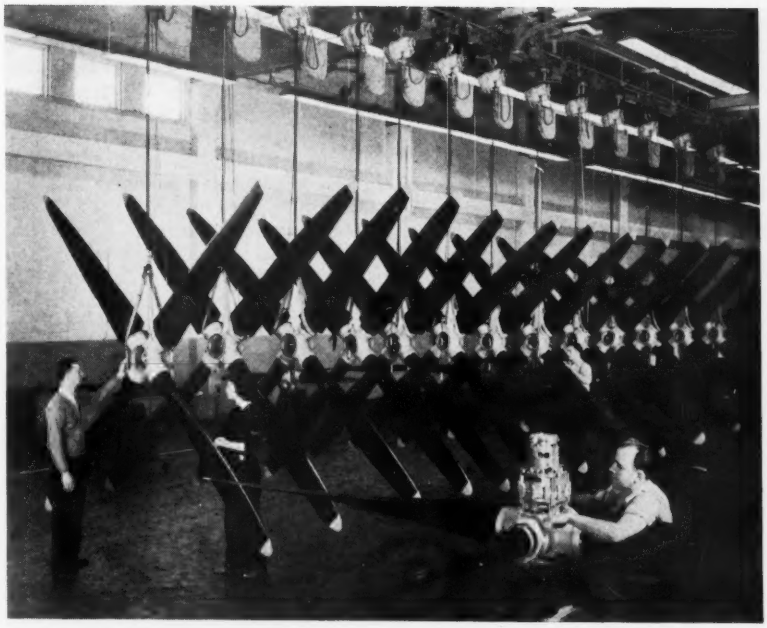
thought and to extend existing ideas. It deals particularly with the manufacture of aircraft parts. Advantages of the rubber matrix system are outlined and conditions under which this system should not be used are mentioned. In discussing the properties of rubber the writer explains that rubber must be considered as a controlled fluid. It will compress only to a small degree but will displace very readily. The conditions affecting this displaceability are enumerated. The range of hardness or "yield" values required for tooling processes is discussed. The writer describes the processes that are now available in which rubber is widely used. These include the hydraulic presses, drop hammers or stamps, and the process of bulging rubbers, where the rubber matrix in constant form is not employed but block shapes are used for individual jobs. The vacuum bag process for shaped, plied material, such as wood in various forms which may or may not include sheet metal in the assembly, is also mentioned. Lubricants and processing details are discussed. *Sheet Metal Industries*, March, 1943, pages 467–476, 496, 16 illus.

Some Recent Developments in Sheet Metal Fabrication. P. L. Smith and V. L. Brooks. Some refinements in the sheet metal processes used by the aircraft industry in the production of all-metal airplanes are outlined. Several significant refinements in the Guerin process are described. Information on the new drop hammer die technique is given. *Automotive and Aviation Industries*, March 1, 1943, pages 22, 23, 53, 4 illus.

Curtiss-Wright's Shop Priority Control System. W. J. Shepherd. A detailed explanation of Curtiss-Wright's priority production system for the control of material, tools, and fixtures to meet delivery schedules. The complete procedure is outlined, each record sheet is described, and the coordination of each department is indicated. *Aero Digest*, March, 1943, pages 216, 219, 220, 382, 5 illus.

Correct Use of Rubber Hose. Stanley S. Kogut. Advice is given on how to handle and maintain rubber hose in aircraft plants so that maximum efficiency and durability may be obtained. Causes for deterioration and waste are demonstrated, with methods suggested for the counteraction of destructive agents and procedures. Standardization providing for a minimum number of sizes and types of rubber hose to be used in a plant is advocated. Among the problems discussed are those relating to storage, oil damage, failures at couplins, welding hose, paint hose, water hose, and sand blast hose. *Aviation*, March, 1943, pages 157, 158, 362, 366, 368, 369, 7 illus.



Completed Curtiss electrically controlled four-bladed propellers are carried along a conveyer to the final balance room in their Indiana plant.

Automobile Assembly-line Technique Applied to Airframe Production. Chester S. Ricker. How the Hudson Motor Car Company has applied automobile assembly-line technique to the production of air frames is described. Advantages realized by the method are stated to include increased accuracy, the faster production of parts, simplified assembly, and reduced worker-training time. *Wings*, March, 1943, pages 398–400, 5 illus.

Buick Aluminum Foundry Embodies Best Practices for Mass Production of Aircraft Engine Cylinder Heads. Foundry methods used by Buick in the production of aluminum for aircraft cylinder heads are outlined. The writer describes novelties in techniques and equipment which are stated to have improved the quality of the cylinder heads, reduced rejects, and raised the ceiling of productivity. *Automotive and Aviation Industries*, March 1, 1943, pages 26–29, 47, 10 illus.

Centralized Planning for Small Plants. John H. Stephens. The production control system used by the subcontracting firm of Aircraft Products Company is related in detail. A description of each of the four units in the system—traffic ledger, tooling sheet, delivery schedule, and loading chart—and its function in the process is followed by an example in which a hypothetic order is handled from beginning to end. Designed primarily for small plants, the total cost of operation is reported to be less than 1 per cent of the gross sales. *Aviation*, March, 1943, pages 217, 219, 221, 223, 225, 2 illus.

Rivet Sorter. A new rivet-sorting machine, developed by the Fisher Body Division of General Motors, is described. Effecting economies of time and material, this device performs three operations—assorting the rivets according to material types, head types, and lengths. *Western Flying*, March, 1943, page 47, 1 illus.

Studebaker Know-How Speeds Flying Fortress Engine Output. Joseph Geschelin. An article is presented on production operations at Studebaker's main plant, which is manufacturing major structural elements of the Wright Cyclone engine and handling the assembly, testing, and shipping of these engines. The buildings in which these operations are carried out and the machine tools employed are described. Reference is made to the Greenlee cylinder-head machining battery, developed and perfected through the joint efforts of Wright, Studebaker, and Greenlee, which is stated to represent an investment of approximately $750,000 to $800,000 including the tooling. Machining methods and techniques are described in considerable detail. *Automotive and Aviation Industries*, April 1, 1943, pages 18–22, 70, 72, 74, 8 illus.

Record of Achievement in Canada's Aircraft Industry in Time of War. William A. Hunter. Confined strictly to its aircraft division,

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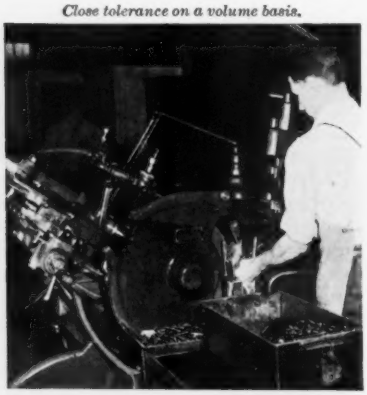

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this is a recapitulation of Canada's war effort since the commencement of hostilities. The first article describes the growth of the industry and surveys the organization of production, companies participating in the aircraft-building program, types of planes now being produced, personnel, direction, and morale.

The leading article is followed by individual articles on each of these Canadian companies and the airplanes that they manufacture or service: DeHavilland Aircraft of Canada, Ltd., Canadian Vickers Ltd., Fairchild Aircraft, Ltd., Fleet Aircraft Ltd., Noorduyn Aviation Ltd., Victory Aircraft, Ltd., Boeing Aircraft of Canada, Central Aircraft Limited, MacDonald Bros. Aircraft Ltd., Ottawa Car and Aircraft Ltd., Canadian Car & Foundry Company, Ltd.

There are also articles on two engine maintenance companies: British Aeroplane Engines, Ltd., and Canadian Wright Ltd. Finally, a Catalogue and Directory lists Canadian firms supplying equipment of all types for aircraft construction, aircraft maintenance, and airport construction and maintenance.

The articles are as follows: "From Moths to Mosquitos," pages 60, 62, 64, 12 illus.; "Pioneering The Amphibian in Canada," pages 66, 68, 90, 15 illus.; "An Ever-Expanding Horizon," pages 70, 72, 74, 12 illus.; "Wings for the Empire's Eagles," pages 76, 78, 9 illus.; "An Outstanding Contribution to Canada's Air Training Plan," pages 80, 82, 84, 13 illus.; "'V' Stands for Victory," pages 88, 90, 5 illus.; "Boeing of Canada Makes Canada's Coastal Defenders," page 92, 2 illus.; "Aircraft Maintenance and Overhaul," by E. J. Hatton, pages 94, 96, 98, 4 illus.; "Contribution from the Mid-West," pages 100, 102, 5 illus.; "Proper Maintenance Ensures Efficient Flight," page 104, 3 illus.; "Hurricanes to Hell-Divers," pages 106, 108, 5 illus.; "Engine Maintenance for the R.C.A.F.," pages 124–126, 16 illus.; "Keeping Canada's Aircraft Flying," pages 128, 130, 4 illus.; "Catalogue and Directory," pages 132, 134, 136, 138, 140, 142, 144, 146, 148, 150, 152, 154, 156, 158, 160, 162, 164, 166, 168, 170, 172, 174, 176, 178, 180, *Commercial Aviation*, February, 1943; "Canada Gains Vital New Production Role," by Raymond L. Hoadley, *Aviation*, March, 1943, pages 92–95, 342, 344, 347, 348, 8 illus.

Propellers

Welding of Aircraft Propeller Blades. C. A. Liedholm. In introducing this discussion on the weld-

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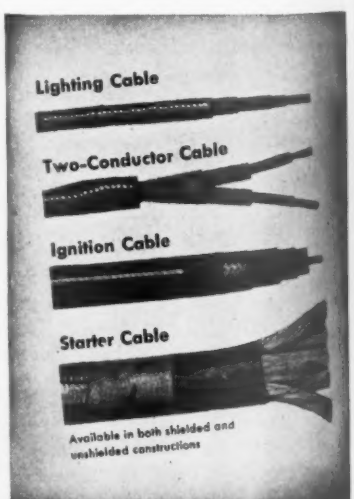

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Lightning Fighter

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Dependable

DUNCO MERCURY RELAYS

NON-WELDING, DIRT-FREE CONTACTS

Dunco Mercury-Contact Relays have established enviable standards of performance on applications where high inrush loads, such as on lamps and motors, must be controlled, or for use where dust and fumes might foul ordinary contacts.

Rugged, heat-proof glass tubes keep the mercury in perfect condition, guarding it against fouling from contact with metal parts. On the Dunco Laminated Clapper Type Relays (Series 91), these tubes tilt over a wide angle, assuring positive contact without the need for any unusual mounting precautions. Dunco Mercury Swing Types (Series 22) require level mountings. These units have the advantage of making noiseless contact, and being lower in price.

Other Dunco Relay-Timer Types

30 ampere—Sensitive—Instrument Controlled—Low Voltage, Heavy Current, D.C.—Mechanical Latch-in (Electrical Reset)—Telephone Auxiliary—Lamp Controlling—Polarized—Overload—Timing—Industrial Control and Power Transfer—Sequence, Ratchet Type—Motor Reversing, and many others.

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ing of propeller blades, reference is made to advances in propeller design and their effect on the development of larger and faster aircraft. Advantages of hollow steel blade design are outlined. It is explained that hollow steel blades permit savings in weight that increase with the propeller diameter. The procedure followed in the manufacture of Curtiss hollow steel propeller blades is described. These blades are assembled through the welding together of two component parts—the camber or curved plate, which is rolled up in one end to form the shank, and the thrust or flat plate. Operational steps in the manufacture are enumerated. The article gives information on welding, heat-treating, finishing, and inspection operations. In summarizing the subject the writer points out that the fabrication of hollow steel blades made from tapered and formed plates has been accomplished through the adaptation of the design to the physical properties of the weld, the careful selection of raw materials, advanced manufacturing methods, and rigid production and inspection control. *The Welding Journal*, March, 1943, pages 165–172, 21 illus.

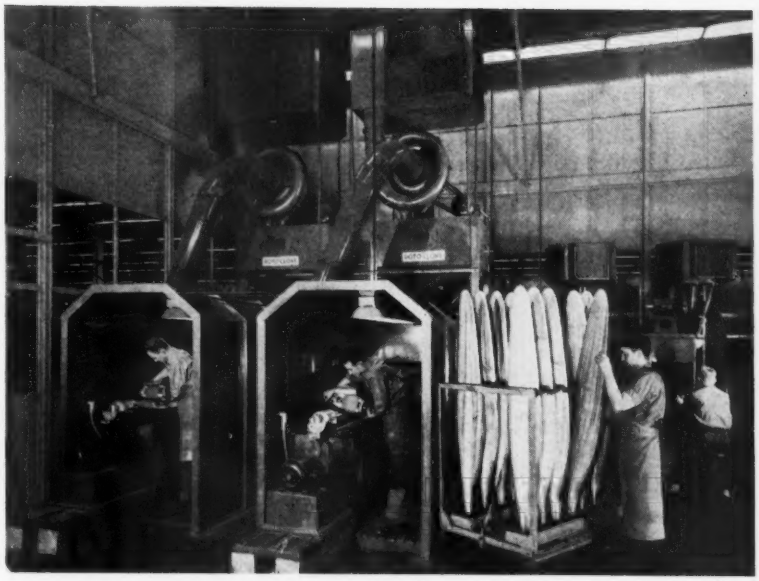
Canada Helps Deliver Texans. Esther H. Forbes. The genesis and development of Canadian Propellers, Ltd., are described. Organized in April, 1941, as a subsidiary of Canadian Pratt & Whitney, this company manufactures two-way controllable-pitch propellers for the North American Texan. The article contains data on its personnel, plant and equipment, and output. *Southern Flight*, March, 1943, pages 38, 39, 4 illus.

VDM Propeller Pitch Changing Mechanism. The mechanical design of the V.D.M. pitch-changing mechanism for propellers, which is used on the B.M.W. 801A engine, is described. It is explained that the development comprises two separate devices, one for regular use and the other for emergency use. The first is hydraulically operated and automatically controlled, while the second is electrically operated and hand controlled. Design details of this pitch-changing mechanism, which includes a speed governor, are given. *Automobile and Aviation Industries*, February 15, 1943, pages 40, 41, 2 illus.

Radio

Radio Tubes at Work. Lt. Myron Eddy. The design and general operating characteristics of typical different types of radio tubes used on airplanes are described in this article. Sectional illustrations of a typical metal tube for receiving and of a transmitting beam tube are presented. *Air Tech*, April, 1943, pages 46, 47, 65, 66, 6 illus.

Radio Direction Finders. Max Charles. A brief description of the radio direction finder and how it is used is presented. Discussing the application of direction finding, the writer explains the three ways in which ground stations can direct aircraft. *Canadian Air Cadet*, March, 1943, pages 11, 24, 3 illus.



Workmen, in the newly erected Indiana propeller factory of the Curtiss-Wright Corporation, sand propeller blades inside small booths equipped with an up-to-date dust-removal system.

Rotating Wing Aircraft

A Dream Come True. C. L. Morris. The operation of the helicopter is explained in detail by the holder of helicopter-pilot license No. 2. He leads the reader through an imaginary flight in a helicopter. Instrument panels and controls are described, and he calls attention to both the differences and similarities of the helicopter and a conventional airplane.

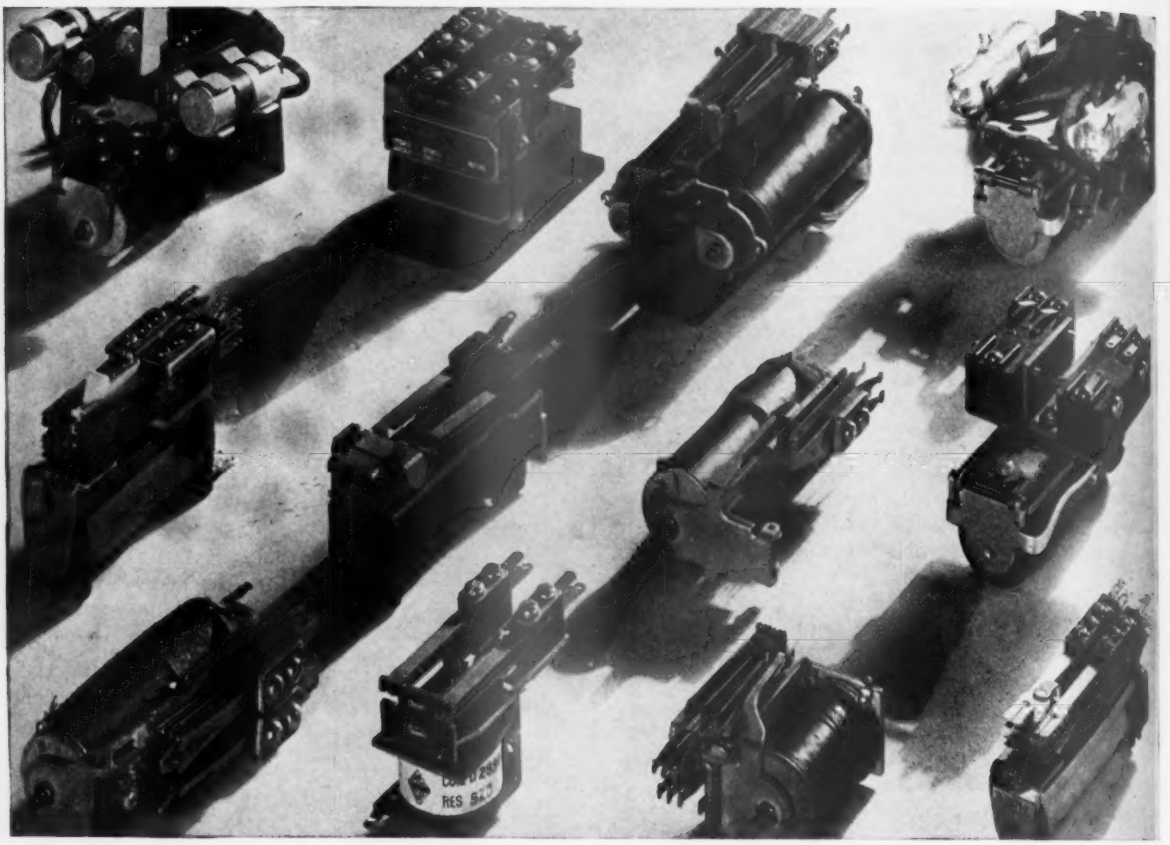
In a summary of the advantages and disadvantages of the helicopter, its shortcomings are listed as speed, load, and range. However, the writer stresses the compensating features of the aircraft and tells why it is destined for a great postwar future. *Air Facts*, April, 1943, pages 7–14, 16–20, 5 illus.; "Helicopter at War," *Air Tech*, April, 1943, pages 21, 65, 66, 2 illus.

Stress Analysis

General Instability of Monocoque Cylinders. N. J. Hoff. The different types of general instability already discussed in literature are critically reviewed. The writer's earlier theoretic calculations of the critical load of the inward bulge type of general instability are revised in the light of the experimental data of a GALCIT investigation. A new simple formula is derived which is in reasonable agreement with experiment. *Journal of the Aeronautical Sciences*, April, 1943, pages 105–114, 10 illus.

A Tabular Method of Propeller Blade Stress Analysis. Joseph Stuart III. A tabular, trial-and-error method of evaluating the steady bending stresses in a rotating propeller blade is developed and examples of its application are given. The bending moment at a shank section of the blade is estimated and, by tabular integration, the corresponding radial bending moment distribution is calculated. Additional trials with appropriately revised shank section bending moment estimates are made until the correct distribution is found, having the physically required moment value of zero at the blade tip.

Tilted blades and blades whose section centers of gravity do not in general fall on the blade axis are shown to be readily analyzed. Because the final analysis can be quickly checked on a calculating machine and because the method is easily learned, versatile, and fast, its general adoption by the propeller industry is advocated by the author. *Journal of the Aeronautical Sciences*, April, 1943, pages 115–118, 5 illus.



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Relays
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General Equations for the Analysis of Elliptical Rings. Daniel O. Dommasch. The analysis of bulkhead rings is at best a tedious process, and it is felt that any simplifications will be of help to the aircraft structural engineer.

Of the several methods of analysis available, that outlined by Lundquist and Burke, "General Equations for the Stress Analysis of Rings," *N.A.C.A. T.R. No. 509*, 1934, seems to be the simplest and most widely used. This paper is based on the general method of the N.A.C.A. report and presents, in particular, the application of the report to elliptic and circular frames. In addition, some general simplifications based on symmetry and load conditions are presented.

No attempt has been made to break down the analysis into a number of specific solutions, but rather simplifications of the basic equations are presented which apply to any loading condition.

A set of curves is presented at the end of this article from which the length, moment of length, and moment of inertia of the length of an ellipse may be determined. *Journal of the Aeronautical Sciences*, April, 1943, pages 119–126, 11 illus.

Testing

German Medium Bomber Design. Information and performance data obtained from tests of an enemy aircraft are presented. Following a description of the plane—a Junkers 88, type A-6, medium bomber—the program of tests is outlined. Figures are given on the speed, climb, take-off, and fuel consumption of the plane. *Aeronautics*, March, 1943, pages 52–54, 3 illus.

Testing Equipment

Flight-Testing Equipment for Large Aircraft. W. T. Dickinson. Recent advances in the design of flight-testing equipment for large airplanes are described. The author refers to the first modern flight-testing equipment used for testing the Douglas DC-4, which necessitated the manual recording of data and the use of a flight crew of from twelve to 22 men. Automatic flight-recording and temperature-recording equipment used for testing modern large aircraft (such as the XB-19), which gathers all information on the operation of the engines, the controls, and the performance of the plane, is described. The writer tells of interior changes in the design of the plane which had to be made to take care of this flight-test equipment. Figures are presented on the weight and cost of the equipment. *S.A.E. Journal*, April, 1943, pages 139–147 (Transactions), 14 illus.

Sand blasting foreign particles from hollow steel tubing at a Boeing Airplane Company plant.

Tools and Equipment

Dimensions of Forging Die Blocks. Paul Patek. Controlling considerations in the selection of forging die blocks are discussed in this paper. The dimensions of the forging in the plane of separation between the upper and lower portions of the die and to other factors influencing design are given. Rules for determining the die wall thickness and the die heights, established after much research and practical experience, are also presented. *Heat Treating and Forging*, March, 1943, pages 129–131, 149, 5 illus.

Training

The Workmanlike Manner. E. C. Bailly. Demonstrating the importance of assiduous attention to detail in basic training, the writer suggests systematization in checking details. He points out how a set pattern of habits in the beginning prevents a student from acquiring slipshod methods in his more advanced flying. Among other things, a systematic approach is advised for checking instruments and settings, cockpit checks, and controlling the attitude of the airplane. *Air Facts*, April, 1943, pages 21–27.

Photos Help Train Assemblers. Ben F. Silsbee. How the Bell Aircraft Corporation uses photographs to aid in training assemblers is described. Photographs are used to show green hands the way to perform jobs with parts and tools with which they are unfamiliar. Each step is pictured and labeled to identify units and provide ready-reference instructions. *Wings*, March, 1943, pages 395–397, 10 illus.

Sandor Synchrophone. The construction and operation of a combination sound-and-film device for training purposes is explained. Called the Synchrophone Training Picture, this device consists of two units: one, a sound unit that plays phonograph records of the desired lecture; the other, an attached picture frame containing illustrations of the subject. As the record progresses, an electrical arrangement causes different parts of the illustration to be illuminated; thus emphasis is placed upon the particular detail of the mechanism being studied. The article suggests various applications for this equipment. *Flight*, February 4, 1943, page 130, 1 illus.

Army Glider Instruction. Charles E. Higgins. The glider phase of the Army Air Forces basic training program is described. Various glider flight maneuvers, problems common to the glider student, and the equipment used are detailed. Oscillation correction and coordination exercises are two aspects of the instruction noted particularly. *The Sportsman Pilot*, March, 1943, pages 16, 17, 41, 3 illus.

Aviation in the Classroom. S. K. Hargis. This article describes the nationwide aviation training program conducted in schools and colleges. It is explained that the program has the double objective of training youths for flying, building and servicing airplanes in wartime, and preparing the nation for changes that peacetime air transport will make in everyday living. *Air-Age*, April, 1943, pages 34, 35, 66, 67, 5 illus.

Tough Pilots. Charles A. Keefer. This article describes the 220-yard obstacle courses that have been established at every Third Air Force base to further the physical perfection program of the Army Air Forces. It indicates how the various rigorous exercises help to equip cadets with the necessary stamina for arduous flights. *Flying*, April, 1943, pages 30, 31, 4 illus.

The C.A.A. Explains Itself. R. McLean Stewart. One of its executive directors interprets the present program of the C.A.A. War Training Service. He explains the changes that have been occasioned by the man-

They're on the last lap

These machine gun bullets are boring their way toward a Jap Zero—about to complete a job that started several hundred miles back.

Gunpowder shot them down the home stretch—but gasoline carried them most of the way.

A fighting plane is a machine gun nest on wings—a flying "pillbox" that has to be maneuvered into position. Pilot's skill and engine power do the maneuvering; engine power, in turn, depends largely on the quality of gasoline the engine can be designed to use.

Long before the war, chemists and engineers of America's petroleum industry matched brains for ways to make new and better aviation fuel. War found the industry ready to roll—ready to turn out the vast quantities of "fighting grade" gasoline necessary for sky supremacy.

Into each gallon of this super-gasoline—and into the military gasoline for motorized land and sea weapons—goes Ethyl antiknock fluid. It boosts already high octane ratings still higher; it packs in that extra punch.

Ethyl has gone to war—on every front where gasoline is used. And when at last the war is won, these new and better fuels "with Ethyl" will help America lead the world again in aviation and in automotive transportation.

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power directive of December 5, 1942, prohibiting voluntary enlistment and reports some plans that are contemplated for the future. After going into detail about arrangements that have been made for obtaining training planes and replacement parts, he examines several problems attendant upon the conversion of the C.A.A. to a war footing. These include the completion of training for enlistees already started as well as the selection of flight-training centers and colleges for the current program. *Southern Flight*, March, 1943, pages 34, 36.

Bombs for Berlin. The training of bombardiers as carried out at the Victorville Army Flying School is described in considerable detail. Bombardiers are sent to this school after primary preflight training. It is explained that the Victorville school is one of the few that uses the series type target in target practice. A series of targets are spread over an area of several hundred miles and each is approached from a different direction. How this helps the student in learning navigation, and the use of the computor are outlined. *American Pilot*, March, 1943, pages 9–11, 3 illus.

"Greatest Individual Effort." Some brief comments are made of the British Commonwealth air training plan and its importance to postwar civil aviation. *Flight*, February 25, 1943, page 210, 1 illus.

Men Behind the Headlines. Lt. Col. Franklin Rose. The activities and curriculums of the Los Angeles Civilian Schools Area Division of the Army Air Forces Technical Training Command are given by its commanding officer. On the basis of a civilian school setup operated by an Army organization, this area includes seven aircraft factory schools, six private aeronautical schools, one business college, three universities, and one college—each operator under contract with the Technical Training Command to train a given number of men within a certain period of time.

Twelve types of technical training are conducted: sheet metal, inspection and maintenance, airplane mechanics, engine overhaul, aircraft electricity, aircraft instruments, aircraft welding, propellers, parachute rigging, air frame (special training on individual types of aircraft), premeteorology, and clerical (engineering and operations clerks and staff assistants). *Western Flying*, March, 1943, pages 44–46, 80, 4 illus.

Who Goes There? James Montagnes. The article describes how air crew candidates for the Royal Canadian Air Force are trained in aircraft recognition. Emphasizing the importance of this course, the writer points out that the speed of modern warplanes leaves little time for the pilot or crew to decide on the nationality of approaching planes. Details of the course, which is preceded by lectures on the theory of flight, are outlined. *Air Trails*, April, 1943, pages 20, 21, 3 illus.

Major Clarence A. Shoop, Assistant A.A.F. Resident Representative at Lockheed, demonstrates how a student pilot rides "piggyback" in a Lockheed Lightning P-38. The plane is being piloted by Jimmie Mattern, Lockheed test pilot. (*See* page 128.)

Communications School. Lewis Winner. A description of the Melville School's training courses for aircraft communications personnel. In addition to transmission of messages, modern radio technique, and the construction and maintenance of various types of communications equipment, the curriculum covers a multitude of topics peculiar to flying practice. These are briefly outlined in the article. *Flying*, April, 1943, pages 78, 80, 156, 158, 4 illus.

Warfare

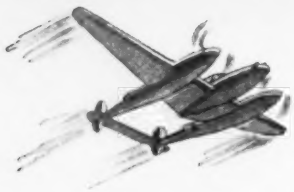
Marine Airmen on Guadalcanal. Major Gen. Ralph J. Mitchell. The performance of United States Marine Corps fliers and their airplanes during six months of struggle for possession of Guadalcanal is reviewed by one of their generals. He accentuates the achievements of all the marines on Guadalcanal by relating the exploits of a few representative ones. Factual data includes a tabulation of damage done to Japanese shipping by Marine Corps dive bombers from August 25, 1942, to January 1, 1943. *Flying*, April, 1943, pages 22–24, 163, 164, 6 illus.

Fighter Tactics. Keith Ayling. This is a detailed study of the tactics upon which fighter combat is based. It covers the evolution of formation flying and the principles of attack and interception. The importance of teamwork is stressed, present-day fighter tactics are compared with those of the first World War, and several strategic maneuvers are explained.

Among the rules noted for fighter pilots are that they: be able to recognize enemy planes, be familiar with the fighting characteristics of enemy planes, and disengage from action after delivering the first blow. *Flying Cadet*, March, 1943, pages 5–9, 56, 10 illus.

La Aviación Sanitaria, Factor Decisivo en el Problema de la Evacuación de Bajas en una Guerra Moderna (Sanitary Aviation, a Decisive Factor in the Problem of the Evacuation of Casualties in Modern Warfare). José Aparicio and José Luis Álvarez Sala. The first installment of a two-part article gives a historical review of the development of sanitary aviation. It is shown that from modest beginnings in the first World War it has made great progress, with experiences gathered during the French and English colonial campaigns in Palestine, Syria, and Morocco. The article refers to the use of flying boats as ambulance planes for the Navy. *Revista de Aeronautica*, November, 1942, pages 353–355, 3 illus.

DESIGNED FOR WORK "Upstairs"



A tough synthetic sheath, providing exceptional resistance to moisture, heat, oil and corona, distinguishes the Packard high-tension cable that has been adopted for high-altitude flying by the Army Air Forces.

Ten years of Packard pioneering and development are behind this type of cable, which has won wide acceptance wherever extreme conditions of service are encountered. Now refined and improved, Packard high-tension aircraft cable with the synthetic sheath is helping meet the problems of the "40,000-foot ceiling." Packard Electric Division, General Motors Corporation, Warren, Ohio.

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PACKARD CABLE SERVES THE ARMED FORCES
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ARMY E NAVY

La Aviación Sanitaria, Factor Decisivo en el Problema de la Evacuación de Bajas en una Guerra Moderna (Sanitary Aviation as a Decisive Factor in the Problem of the Evacuation of Casualties in Modern Warfare). José Aparicio and José Luis Álvarez Sala. The second and concluding installment of this article on the organization and operation of sanitary aviation deals with its application in warfare. In order to carry out its work properly the writers propose that sanitary aviation be given sufficient air protection. However, it is stated that this would be contrary to the Geneva Convention and the suggestion is made that the Red Cross should find a way to modify the Convention in this respect. After a description of the application of sanitary aviation in the Russian campaign, an outline is presented of the most efficient use of sanitary aviation in modern warfare. *Revista de Aeronautica*, December, 1942, pages 432–434.

Bacteria in Aerial Warfare. Lucien Zacharoff. The writer suggests that in desperation the Axis may resort to bacteriologic warfare. He outlines methods devised to spread bacteria and discusses antibacterial defense. *Air-Age*, April, 1943, pages 30–32, 64–66, 2 illus.

Welding

Adapting Automatic Electric Welding to Routine Production. J. M. Keir. This paper deals with the Unionmelt automatic electric welding process. The writer discusses the types of backing used in making Unionmelt welds, the available grades of rod, and the proper use of Unionmelt material. The types of installations used for various applications are described. *The Welding Journal*, March, 1943, pages 173–179, 12 illus.

Arc Welding Aircraft Structures. Part 2. W. S. Evans. The second section of this article discusses the advantages of arc welding such structures as engine mounts, exhaust fairings, and landing-gear support assemblies. The process as applied to a landing-gear support assembly is described in detail, the arc-welding method being compared with the former method of gas welding. Thirteen steps are outlined for the completion of the work. In a similar manner the procedures in arc welding an engine-mount assembly and an exhaust fairing assembly are explained, with tabulations showing the comparative time and costs for gas welding and arc welding. *Aero Digest*, March, 1943, pages 177, 178, 180, 181, 183, 11 illus.

Spot-Welding as Applied to Aircraft Structures. E. S. Jenkins. The final article of a series on the spot welding of aircraft structures is presented. In concluding this discussion of the comparative strength and efficiency of spot welds and rivets, the relative merits of complete assemblies, using two methods of fabrication, are considered. *Sheet Metal Industries*, March, 1943, pages 499–501, 516, 7 illus.

Hardness vs. Wear Resistance. J. R. Spence. It is explained that, while practically all hard-facing metals are of the hard-type alloy, there are many alloys in common use possessing great hardness which cannot be termed hard-facing alloys, high-speed steel being one example. In the development of alloy steels for use in their heat-treated condition, hardness and strength are of prime importance, while in the development of hard-facing metals the factor of most importance is the ability of the metal to withstand wear. Problems connected with the selection of hard-facing alloys for various applications are discussed. Illustrations show worn parts repaired with Stoodite 45 hard-facing alloy. *The Welding Journal*, March, 1943, pages 179–181, 4 illus.

Miscellaneous

Annual Directory of Manufacturers of Airplanes, Gliders, Engines and Accessories. In its annual directory number, *Aero Digest* publishes a comprehensive alphabetical list of aircraft, engine, glider, and accessory manufacturers, as well as an index of accessories used in aircraft and aircraft engines. It is stated that specifications of warplanes and engines are not included because of wartime restrictions. *Aero Digest*, March, 1943, pages 281, 283, 288, 294, 297, 298, 302, 306, 308, 313, 314, 318, 320, 322, 328, 331, 332, 334, 338, 347, 348, 353, 356, 359, 360, 362, 424, 1 illus.

On Total War Power. C. G. Grey. The writer decries the fact that both in civil life and in the armed services Great Britain is misapplying or neglecting to exploit talent and ability. To prove his point he recites several varied examples of persons who have not been fitted into the jobs for which they are best suited. Marking the discontent fermented by such situations, he states that tota' war power cannot be achieved until the evil is corrected. *The Aeroplane*, February 19, 1943, pages 212, 213.

Theory and Technique of Perspective Projection. Part II. George F. Bush. The second of a series of articles on graphic projection fundamentals details two-point projection, including inclined vanishing points and reductions and enlargements. A comparison is drawn between Method 1, explained in Part I and Method 2, which is covered in detail in the current installment. It is shown that the first procedure is simpler than the second. The geometric treatment is detailed as typical of the mathematical approach that can be used in conjunction with a graphic method. Two engineering perspectives that employ the two-point principle are reproduced; one is an "exploded" assembly presentation of the fuel tank release mechanism used by North American Aviation; the other, a partly sectioned perspective of the final assembly of the tab control mechanism of the Lockheed Lodestar. *Aviation*, March, 1943, pages 150, 151, 153, 6 illus.

Truly Vital Statistics. The major part of the twenty-fifth annual statistic issue is devoted to data and specifications. There are sections covering war production, man power, materials, general industrial data, and automotive and aviation data. The aeronautical section includes data on air-line miles flown, passenger and express carried, the number of airports and landing fields in the United States, airplane-engine and parts production and their value, the popular names of United States military aircraft, and S.A.E. and N.A.S.C. standards. Specifications of military airplanes of the world are classified according to types and countries. The specifications of American aircraft engines; standard car, truck, industrial, and marine gasoline engines; and Diesel engines are also presented. Numerous charts and detailed tables are included. *Automotive and Aviation Industries*, March 15, 1943, pages 53–126, 44 illus.

Aviation's 1943 Yearbook. *Aviation's* 1943 Yearbook contains information on the world's leading operating aircraft. Photographs, three-view silhouettes, and performance data are included. The compendium is divided into sections on American, British, Russian, Italian, German, and Japanese military aircraft. Fighters and bombers of all these countries are described, as well as cargo transports of all but Italy and Japan. In the American section data are also listed on observation, liaison-trainer, and glider planes.

There is also a section on American aircraft engines and one on specification tables. Constituting compilations of releasable information on American aircraft and engines, together with available data on both Allied and enemy air force components, the tables cover American and foreign military aircraft, American military gliders, American aircraft engines, and foreign military engines.

Three directories are included in the Yearbook. The first, called a Directory of the Industry, lists alphabetically all prime contractors, plant addresses, names and positions of key personnel. It is subheaded: aircraft manufacturers, glider manufacturers, engine manufacturers, air lines, and aviation schools. The Directory of Products and Suppliers is an alphabetical list of products used in aircraft and engine manufacture, supplemented by the names of the makers. In the third directory—the Directory of Suppliers' Addresses and Personnel—the suppliers' names are scheduled alphabetically, regardless of the products supplied. Their addresses and the names of key personnel are also given.

The sections are as follows:

American Military Aircraft, Fighters, Bombers, Cargo-Transport, Observation, Liaison-Trainers, Gliders, pages 181, 183, 185, 187, 189, 191, 193, 197, 199, 201, 203, 205, 207, 192 illus.

British Military Aircraft, Fighters, Bombers, Cargo-Transport, pages 209, 211, 215, 217, 219, 76 illus.

Russian Military Aircraft, Fighters, Bombers, Cargo-Transport, pages 221, 223, 225, 227, 60 illus.

Italian Military Aircraft, Fighters, Bombers, pages 227, 229, 26 illus.

German Military Aircraft, Fighters, Bombers, Cargo-Transport, pages 231, 233, 235, 237, 58 illus.

Japanese Military Aircraft, Fighters, Bombers, pages 239, 241, 36 illus.

American Aircraft Engines, pages 243, 245, 246, 12 illus.

Specification Tables, pages 255–262.

Aviation's Directory of the Industry, pages 265, 267, 269, 271, 272, 273.

Directory of Products and Suppliers, pages 275, 277, 279, 281, 283, 285, 289, 291, 293, 299, 301, 303, 305, 307, 309, 311.

Directory of Suppliers' Addresses and Personnel, pages 311, alternate pages through 329, 333, 335, 337, 339, 341, 345, alternate pages through 357, 361, and alternate pages through 375, 379, 381, 383. *Aviation*, February, 1943.

"ME? I'm going to buy a little farm"

"WHEN WE'VE TAKEN care of Goering's boys, I'm going back to West Virginia and get me a little farm. But I won't be holed-in like the old folks were. I'll have my own plane . . . maybe one of those helicopter jobs they're talking about that can go straight up and down and land in the back yard. Then I'll be able to hop into town, or across the country, any time I want to. With the right kind of instruments, I'll be as free as the air I fly through. And, brother, that's for me!"

WHAT THE PLANE OF TOMORROW *will look like, or how it will perform, we don't exactly know. But we do know that Kollsman research engineers are constantly planning and developing new and better precision aircraft instruments . . . to help smooth out tomorrow's skyways, and give safer wings to a nation at peace.*

THE KOLLSMAN VERTICAL SPEED INDICATOR, *sometimes called Rate of Climb Indicator, is one of the basic instruments for maintaining level flight and for showing the rate of change in altitude. Though highly sensitive, the Vertical Speed Indicator can "take it", even in a power dive.*

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AIRCRAFT INSTRUMENTS
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Government Publications

Army Air Forces

Air Forces Antisub Command. Lt. Col. C. A. Burrows. An article is presented on the Antisubmarine Command, a new component of the Army Air Forces organized to combat the U-boat. It is explained that this command is the only unit of the Army Air Forces within the United States continental limits having a major operational mission or "shooting job." Squadrons of the Antisubmarine Command also operate overseas. The writer discusses the organization of this unit, which dates back to the beginning of the war, and describes its development. How this command is operating against enemy U-boats today is outlined. *Air Force*, April, 1943.

Our Air Defense Network. Brig. Gen. Gordon P. Saville. The Director of Air Defense draws a picture of the vast operations behind America's Aircraft Warning Service. He describes what happens before fighter planes take to the air and explains the way these aircraft are guided to intercept the enemy. *Air Force*, April, 1943.

Camera Scouts. Capt. Milton R. Krims. This article describes the growth of the Photographic Squadron of the Army Air Forces and tells how photographs, charts, and maps of enemy territory are made. *Air Force*, April, 1943.

Guides for Global War. Capt. F. J. Burnham. This is the second of a series of articles presenting basic information for airmen on methods used to chart the earth and deals with map projections. The problem of using flat maps to show the spherical surface of the earth is discussed. Cylindric, conical, and azimuthmal projection systems are described. The advantages and disadvantages of each method are considered. *Air Force*, April, 1943.

Compressibility. Col. Ben S. Kelsey. In this third of a series of articles on compressibility the writer analyzes wave formations in relation to their effects on flight. It is pointed out that while mechanics, physics, and mathematics furnish much information on compressibility there is a great deal that is not known about the subject as applied to aircraft problems. *Air Force*, April, 1943.

National Advisory Committee for Aeronautics

The twenty-eighth annual report of the National Advisory Committee for Aeronautics has been published for the year 1942. This booklet includes the report of the committee's administrative activities, but technical reports are omitted. The personnel and activities of the various subcommittees are detailed.

Civil Aeronautics Administration

A bulletin on the installation of propeller deicing fluid feed strips gives instructions for the roughening of the propeller surface in preparation for the application of deicing covers and strips. The chief of the aircraft engineering division requests that the procedure specified be followed. *Airworthiness Maintenance Bulletin for Transport Type Aircraft No. 3.*

Department of Commerce

Plywood (Hardwood and Eastern Red Cedar). The National Bureau of Standards has issued the second edition of its pamphlet covering Commercial Standard CS35-42. This is one of the commercial standard grading rules established as a universal basis of understanding in the hardwood plywood industry. It is intended that by their general adoption and use much of the confusion hitherto experienced between buyer and seller may be eliminated. This standard provides minimum specifications for four standard grades of bond hardwood plywood made with three different types of bondage having a high, moderate, and low resistance moisture. It covers tests, standard thicknesses, widths, lengths, tolerances, recognition, packing, inspection, and nomenclature and definitions. Copies are available from the Superintendent of Documents, Washington, D.C., at $0.10.

U.S. Naval Observatory

The American Air Almanac for January–April, 1943, has been issued. Each daily sheet gives the Greenwich hour angle and declination of the sun, vernal equinox, three planets, and moon, at 10-min. intervals of Greenwich civil time. Two identical tables are given to interpolate the tabulated Greenwich hour angles for intermediate values of Greenwich civil time. Below the interpolation tables are given data for the 22 principal navigational stars. The inside back cover gives the sidereal hour angle and declination of stars. On the front of the flap is a star chart, and on the back of this flap are a table for converting an observed altitude of Polaris into latitude and a list of additional stars.

Tennessee Bureau of Aeronautics

Facts on Aviation for the Future Flyers of Tennessee is the title of a loose-leaf booklet prepared for use in connection with the aviation educational program of the State of Tennessee. After a brief history of aviation in the state and of the development of model airplanes, it gives digests of Federal regulations, model contest rules, aeronautical terms, and definitions of commercial and military aircraft. There are also an article on the basic principles of aerodynamics and a chapter about the weather.

British Information Services

Malta Repays with Interest. An article telling how air power has placed Malta in a position to dominate the central Mediterranean. The writer describes the part this strategic island has been playing in war actions of the past and discusses its importance in future activities. It is explained that this "unsinkable aircraft carrier" can be stocked with aircraft to carry the war to the Axis. *Britain*, March, 1943.

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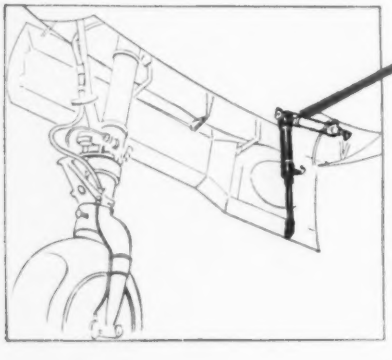

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Physics for Aeronautical Students

The second volume of a two-volume course in physics for aeronautical students is one of a group of indiviual treatments covering the sciences underlying aeronautics. It deals with the structure of the atom, optics, electricity, and magnetism.

In Part I, which is introductory, the author has condensed into 25 pages an outline of the structure of the atom and the phenomena of magnetism and radiation. The avoidance of historic references has aided in making possible a concise explanation of fundamental concepts and principles. Though the book is only intended as an outline, the author goes into the general theory of subatomic energy levels and their relation to radiation, presents the equation for determining the frequency of radiations emitted in an atomic transition, and describes the use of Planck's constant, omitting, of course, its derivation. The reader is given a general perspective of what is known about atoms and radiation and of what is still obscure.

This fundamental background having been furnished, Part II takes up optics, describing emission, reflection and refraction of light, optical instruments, photometry, and dispersion, and presents further information on the wave theory of light. The final portion of the book is devoted to electricity and magnetism. Electricity is discussed under chapters covering static electricity, electrical potential and capacity, and the electric current. Concluding chapters cover electromagnetism, electrical instruments, electrical radiations terrestrial magnetism, and terrestrial electricity.

Sub-Atomic Physics, by Herbert Dingle; The Ronald Press Company, New York, 1943; 272 pages, $2.25.

Fundamentals of Machinery

A book is presented for engineering students who are taking up the study of the motion of machine parts. Information on the motions, velocities, and accelerations of various machine parts is given. The author describes the static forces that may be transmitted in some of the simpler machines and the inertia forces acting on the parts of machines. It is stated that the fundamentals have not been obscured by a large amount of detail. The text covers only those machine parts that are of practical or historical importance. Many principles are presented by means of examples. Problems are furnished at the ends of certain sections. The book is an outgrowth of notes used in connection with a course offered at the University of Maine.

Mechanism, by Irving Henry Prageman; International Textbook Company, Scranton, Pa., 1943; 296 pages, $3.00.

The "So Few"

This book presents a history of the R.A.F. It concerns itself with tracing a continuous development of air combat from the preceding war to the present conflict. While relating the beginnings of British military aviation and describing the heroic air operations of British air power in this war, it offers no comparison of the R.A.F.'s activities then and now but considers them as part of one integral record.

After an introductory section covering the background and evolution of the present Royal Air Force, a section of the book details the Fighter Command, another the Bomber Command, and a third the Coastal Command. The remaining two chapters are devoted to a discussion of air operations in the Middle East and an account of the Eagle squadrons.

From Bird Cage to Battle Plane, by Ralph Michaelis; Thomas Y. Crowell Company, New York, 1943; 248 pages, $2.75.

Flight Instruction

Planned to contain all the information necessary to pass the written examinations for a private and commercial pilot, this book is also of value to those who wish to increase their general knowledge of aviation. Elementary principles are so explained that the reader will require no previous technical training to understand them. Part 1 includes an outline of the development of the airplane and information on elementary physics, airfoils, forces in flight, the action of controls, maintenance, flight instruments and parachutes. In Part 2 the aircraft engine and its accessories are covered, as well as propellers and power-plant operation. The two remaining sections of the book deal with meteorology and air navigation.

Air Pilot Training, by Lt. Comdr. Bert A. Shields; McGraw-Hill Book Company, Inc., New York, 1943; 657 pages, $4.00.

Radio Direction Finding

Radio navigation techniques are set forth in a nontechnical course for prospective pilots. The text is limited to basic information on directing the airplane to a desired destination and does not cover instrument flying. Certain portions of this book have appeared in slightly different form as separate articles in *The Sportsman Pilot* and *Aviation*. The first part of the book describes radio navigation systems and the range system. Following sections take up beam techniques, orientation methods, and the instrument approach, and remaining chapters cover the radio direction-finding loop, D/F loop navigation techniques, position fixes by D/F bearings, the running fix, and the radio compass.

Radio Navigation for Pilots, by Colin H. McIntosh; McGraw-Hill Book Company, Inc., New York, 1943; 171 pages, $2.00.

Study Course in Mechanics

This volume is represented as a complete study course in all branches of aviation mechanics. It includes the latest advances that have been made in the field of aviation mechanics and maintenance. Illustrated with more than 700 detailed technical drawings, photographs, and diagrams, the book furnishes specific instruction in almost every phase of the subject. It incorporates a number of instruction methods stated to be new and original, including an aircraft picture dictionary. Presupposing no previous technical training or background upon the part of the reader, the author relies upon simplified text and detailed technical drawings to carry the reader step by step from the most elementary to the most complicated phases of aviation mechanics.

Aviation Mechanics Simplified, by Henry Lionel Williams; A. Neil Sawyer Company, New York, 1942; 576 pages, $3.95.

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Mathematics Self-Teacher

A self-training course in mathematics written to enable pilots, navigators, and bombardiers to solve problems encountered in actual flight. In the first part of the book arithmetic, geometry, and algebra are reviewed. The reader is then introduced to the type of graphic analysis employed in all branches of aeronautics. Following chapters cover angular measure and scales. Elementary vector analysis clarifies the use of the vector in force and velocity diagrams. Information on how to construct wind triangles also is presented. To help the student check his accuracy, answers to most of the problems are given.

Basic Mathematics for Pilots and Flight Crews, by C. V. Newsom and Harold D. Larsen; Prentice-Hall, Inc., New York, 1943; 153 pages, $2.00.

Vibration Problems

This book is unusual in that it is written to provide information on vibration problems for engineers who have not studied much dynamics. It is intended for mechanical, automotive, and civil engineers and is suited to war training and regular courses below the graduate level. The book requires only a limited knowledge of mathematics. The subject is presented in two parts, each of which may be used as a separate unit. Part I deals with physical phenomena and their significance in engineering dynamics. In Part II measuring technique, typical dynamic measuring instruments, and dynamic testing methods are taken up. Methods of measuring vibrations are fully discussed and the chapter on instruments contains much new material.

Mechanical Vibrations, by R. K. Bernhard; Pitman Publishing Corporation, New York, 1943; 139 pages, $3.00.

Avigation Textbook

Written for students with no previous knowledge of air navigation, this book is intended to enable the reader to obtain a working knowledge of the subject in a short time. Because a useful knowledge of air navigation cannot be acquired without much practical work in chart reading, a large number of exercises are provided, and a specially prepared chart is furnished on which many of the exercises can be worked. The text opens with a description of the aims and methods of navigation. The writer then discusses maps, charts, the wind, fixing and reporting position, plotting, and relative motion. There is a chapter devoted to instruments. Concluding chapters, which beginners may wish to omit, cover astronavigation and radio navigation.

Books reviewed in this section may be borrowed without charge from The Paul Kollsman Library, Institute of the Aeronautical Sciences, 1505 RCA Building West, 30 Rockefeller Plaza, New York, N. Y.

Air Navigation, by E. R. Hamilton; The Ronald Press Company, New York, 1943; 175 pages, $2.00.

The Making of an Airman

Based on a six months' tour of Army Air Forces training centers, two experienced magazine writers tell the intimate and personal details of the making of a combat pilot, bombardier, navigator, gunner, and the other members of the crew of an Army bomber. The story follows the activities of the cadet from the day of his arrival at the Classification Center and the fitting of his first uniform, through his training in military discipline, physical conditioning, preflight primary, basic, and advanced school, to his graduation, the award of his commission, and his entry into active service.

The book is written in narrative style, with interpolations in the form of excerpts from letters from the cadet to his mother telling the details of his work. Numerous incidental anecdotes and the thread of romance running through the story serve to sustain interest in its more serious aspects. A section is devoted to the specific training given to each crew member in the particular specialty he has chosen.

From the Ground Up, by Corey Ford and Alastair MacBain; Charles Scribner's Sons, New York, 1943; 197 pages, $2.50.

Photo Reading for Field Use

A book on aerial photograph reading is offered for enlisted men and officers in the field. The material is based as closely as possible on the field requirements of the Army, but much new copy and many of the illustrations have been prepared especially for the book. Among the subjects covered are finding places on maps, distance and time, elevation and relief, and foreign map reading. Other sections discuss aerial photo reading, military terrain features, scales and azimuth, stereovision, and the resolution of aerial photographs. A list of answers to questions and examples also is furnished.

Map and Aerial Photograph Reading; The Military Service Publishing Company, Harrisburg, Pa., 1943; 187 pages, $1.00.

Welding Lessons

A series of lessons on electric welding has been especially prepared for the student who desires to become a welder. In presenting the subject the aim has been to furnish only the essentials necessary for the student to obtain a fundamental knowledge of electric arc welding. The book contains two parts. Part I includes an outline of pressure, resistance and fusion welding processes, and a description of welding machines, their operation and care. Other chapters cover welding electrodes, the welding booth, welding positions, and welding symbols. An important feature of this section is an extensive glossary of welding terms. Part II is devoted to 31 lessons on electric welding operations and techniques.

Fundamentals of Electric Welding, by William Rice, Albert A. Owens, and Ben F. Slingluff; The John C. Winston Company, Philadelphia, 1943; 138 pages, $1.75.

Fundamental Aviation Medicine

Information on the subject of aviation medicine is given in language intelligible to the layman. Written for prospective aviators, the book deals with those medical aspects of aviation which determine whether the individual is suited physically and mentally to take up training in this field. Following a discussion of general considerations, the author takes up physical requirements and reserves. He then discusses the eye, the ear, equilibrium, and neurophysical composition. The second part of the book is devoted to other systems of the body. Chapters cover the respiratory, circulatory, and digestive systems.

Flying Men and Medicine, by E. Osmum Barr; Funk & Wagnalls Company, New York, 1943; 254 pages, $2.50.

Avigation Workbook

This special workbook for navigation in the air is similar to the navigation notebook used at the United States Naval Academy, but several new sections have been added. The left pages are universal plotting charts with fixed latitude and distance scale. Ordinarily,

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navigation notes and celestial navigation problems are entered on the right pages and the chart work is accomplished on the left-hand pages. The plotting chart may be used for wind drift problems, mooring board problems, or ordinary chart problems. Methods of working typical celestial navigation problems are given. A review of dead reckoning is included in the text. Problems in air navigation such as confront the private and commercial pilot on Government examinations are plotted and the solutions given.

Air Navigation Note Book, by Charles A. Zweng; Pan American Navigation Service, North Hollywood, Calif., 1942; 144 pages, $4.00.

Air Officers' Qualifications

Information on the fields in which a man can become an officer in the Air Corps is presented. The book tells how to become a flying officer, ground officer, noncommissioned officer specialist, and a glider pilot. Opportunities in the Navy Air Force are outlined. General instructions for taking the aviation cadet qualifying test are given. The rest of the book is devoted to sample tests and answers to the examination questions.

Air Corps Practice Tests; Current Book Company, New York, 1942; 128 pages, $1.50.

Students' Avigation Text

A feature of this book on aerial navigation is that it is written especially for the high-school boy and girl. The subject is so presented that the book can be used by teachers of mathematics and physics who have no previous knowledge of aviation. The course is intended to cover one semester, and the work is divided into chapters, each of which is followed by a review test. After an introduction in which the history of flying is outlined and information is given on airplane parts, the forces acting on a plane, and types of navigation, chapters are presented on instruments, meteorology, contact flying, dead reckoning, radio navigation, and celestial navigation. The concluding chapter presents a general review of the subjects covered.

Elementary Avigation, by L. E. Moore; D. C. Heath and Company, Boston, 1943; 222 pages, $1.60.

Statics Textbook

The University of Washington has been offering a course in elementary statics and strength of materials during the first college year because many engineering students leave college before completing their course to engage in subprofessional engineering work. This book is for use in such courses and also for use as a reference for those who later continue their studies largely by themselves. In the solution of problems, stress has been laid on well-organized procedures that are essential for accuracy and efficiency. It will be found that insofar as it is possible only simple algebra, geometry, and trigonometry have been used in the solution of problems. Calculus is employed, however, in developing certain fundamental relationships. Problems follow certain sections of the book, and at the end of most chapters important points are summarized for easy reference.

Elementary Statics and Strength of Materials, by Alfred Jensen; University Book Store, Seattle, Wash., 1943; 195 pages, $2.25.

Book Notes

Between the Thunder and the Sun, by Vincent Sheean; Random House, New York, 1943; 428 pages, $3.00.

A reportorial account of world-wide war, interpreted and analyzed by a well-known foreign correspondent. The author's on-the-spot observations start from 1938. He was in Central Europe, Germany, France, England, the United States, and the Far East at crucial moments when political and military events occurred in those sections. The book presents a definite pattern of the war, stimulated by his militantly anti-fascist views.

Seven Came Through, by Capt. Edward V. Rickenbacker; Doubleday, Doran and Company, Inc., Garden City, New York, 1943; 118 pages, $1.50.

The recital of the adventures and hardships encountered by Captain Rickenbacker and his companions during their 21 days adrift on rafts in the Pacific Ocean is a tribute to the fortitude of the men and a revelation of the qualities of leadership displayed by one of America's outstanding airmen. The first chapter tells of the special mission for the War Department on which the author was engaged, the accident that befell their plane in mid-ocean, and how the crew and passengers succeeded in launching the life rafts with which the plane was equipped. Details are given on how the rafts were sighted by Navy patrol planes, how the rescue was effected, and about the completion of the mission after the author and his companions had recovered from their harrowing experiences.

The High Courts of Heaven, by J. V. Hewes; Doubleday, Doran and Company, Inc., Garden City, New York, 1943; 240 pages, $2.00.

The Battle of Britain forms the central theme of this novel. Telling the story of the R.A.F. during the crucial weeks when England's life was at stake, it describes actual aerial combat, dogfights over Dover, and the desperate defense of Goudehurst airport.

From Perry to Pearl Harbor, by Edwin A. Falk; Doubleday, Doran and Company, Inc., Garden City, New York, 1943; 362 pages, $3.00.

This is a review of the relations between Japan and the United States from 1853 to December 7, 1941, with almost its entire emphasis on the rise of Japanese and American sea power. It summarizes naval contacts and depicts the conflicts that developed in the Pacific area as a result of Japan's insistence upon a dominant role in Asia. Analyzing the fundamental discord between Japanese and American policies in the Pacific, the disastrous effects of neglecting to recognize Japan as a potential enemy of the United States are traced.

I Saw the Fall of the Philippines, by Col. Carlos P. Romulo; Doubleday, Doran and Company, Inc., Garden City, New York, 1943; 323 pages, $3.00.

Based upon a diary kept during the Battle of the Philippines, this is a record of the last stand made by Filipinos and Americans, fighting side by side on Bataan, Corregidor, and in Manila. As the last man off Bataan, the author, native Filipino editor and Colonel on MacArthur's staff, is well qualified to tell the story. He makes it an earnest appeal to Americans to realize the battle ahead of them and why they must fight it.

Test Pilot, by Jimmy Collins; The Sun Dial Press, Garden City, New York, 1935; 178 pages, $0.79.

One of the greatest American test pilots, who was one of that rare species of articulate airmen, tells stories of his flights and of friends' flying experiences. The way he relates them has all the humor, cynicism, and sarcasm of hangar flying. Jimmy Collins had many narrow escapes but kept on making 9-G dives until the last one.

Stories about Lindbergh, Doolittle, Love, and other well-known pilots enliven the book. His testament "I am Dead" is one of the masterpieces of pilot literature.

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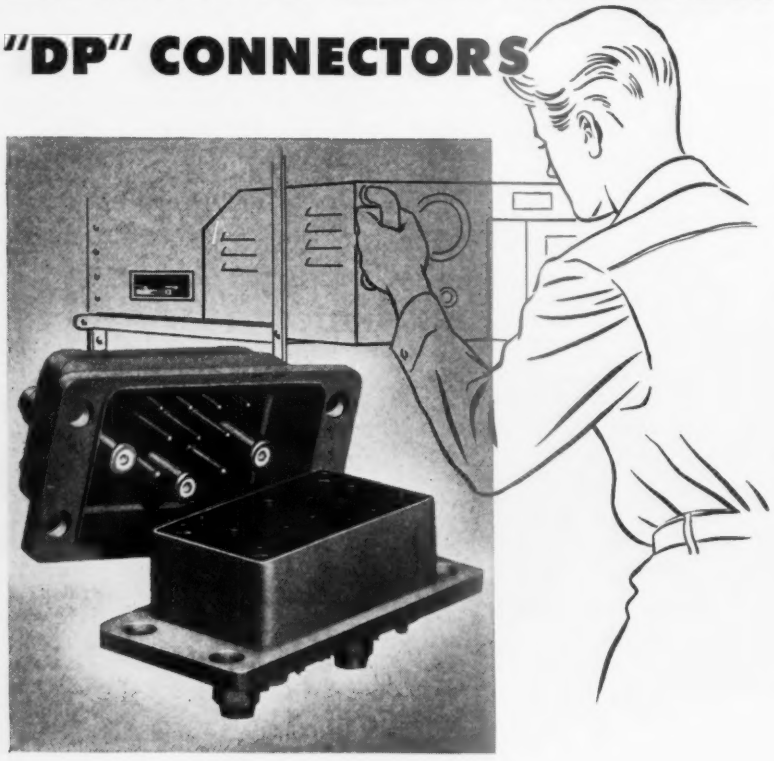

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Bearing Metals, by R. Ruedy; National Research Council of Canada, Ottawa, 1942; 66 pages, $1.00.

This is an introduction to articles on bearing metals published by the author, between 1936 and 1941. Following an explanation of friction and the materials used for bearings, there are four sections which cover tests on bearing metals and bearings, the composition of bearings, the surface finish of bearings, and references.

Learning to Navigate, by P. V. H. Weems and William C. Eberle; Pitman Publishing Corporation, New York, 1943; 135 pages, $2.00.

Presented in revised form, this practical handbook on the essentials of navigation has been enlarged by more than 60 pages and 44 illustrations. There are entirely new chapters on air navigation and piloting and dead reckoning. In addition to the chapters mentioned, other chapters cover the use of charts, the use of the compass, piloting, celestial navigation, time and the timepiece, American almanacs, the sextant, the line of position, and planning navigation for a voyage.

Blackouts and Air Raids—Model Ordinance Annotated, prepared by Charles S. Rhyne; National Institute of Municipal Law Officers, Washington, D.C., 1942; 36 pages, $2.00.

Legal materials that city attorneys may need in drafting ordinances for their cities to meet the problems created by black-outs, air raids, and similar defense activity are presented. The report was prepared with the assistance of the Office of Civilian Defense and the Office for Emergency Management.

Recent References on Air Freight and Express; Library of Congress, Division of Aeronautics, Washington, D.C., October 6, 1942; 6 pages, mimeographed, free.

More than 200 references to periodicals are listed for the years 1940, 1941, and 1942 through September. More than half of the references are for 1942.

Aeronautics Aircraft Spotters' Guide; National Aeronautics Council, Inc., New York, 1942; 94 pages, $0.25.

The fourth quarterly issue of this guidebook presents three-position silhouettes, general specifications, and photographs of warplanes and gliders of the United States, Great Britain, Russia, Germany, Italy, Japan, and France. Descriptions and illustrations of rotating wing aircraft and some lighter-than-air craft are an added feature of this issue. In the opening pages of the guide attention is called to some recently produced aircraft that the spotter should learn to identify.

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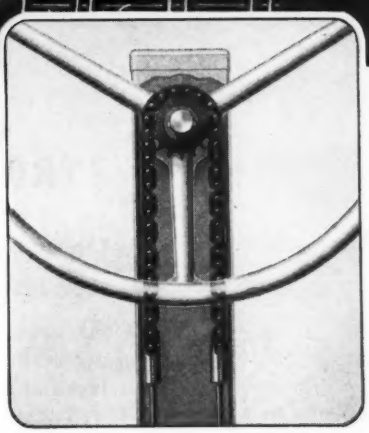

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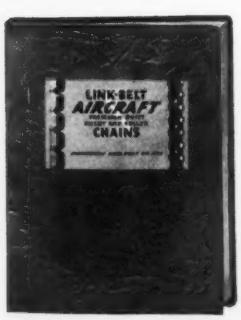

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We Thought We Heard the Angels Sing, by Lt. James C. Whittaker; E. P. Dutton & Company, Inc., New York, 1943; 139 pages, $1.50.

This is the story of the eight men who were lost in the Pacific with Captain Rickenbacker told by the copilot of the plane. The spiritual side of the experience is greatly stressed in this personal history of ordeal and rescue.

Plastics Catalog 1943; Plastics Catalogue Corporation, New York, 1942; 864 pages, $5.00.

The 1943 edition of this annual plastic catalogue is presented. A special section on plastics in war has been added. Another new section covers the history of plastics. The section on synthetic rubber has been expanded. The publishers state that all phases of plastics and their uses are covered in this encyclopedia.

X-Rays in Research and Industry, by H. Hirst; Chemical Publishing Company, Inc., Brooklyn, N.Y., 1943; 129 pages, $2.50.

A study is presented of the principles of x-ray technique in research and industry. Based on a series of lectures given before the Melbourne University Metallurgical Society, the book deals with problems in research, industry, and physical metallurgy in particular. Despite the broad scope of the subject covered, the book is compact in form. Opening chapters discuss the production of x-rays and their properties. The following sections cover the structure of crystals, methods of crystallographic examination, applications of x-ray methods, and industrial radiography.

Chemical Technical Dictionary, by A. W. Mayer; Chemical Publishing Company, Inc., Brooklyn, N.Y., 1942; 872 pages, $8.00.

A chemical dictionary containing chemical terms in English, German, French and Russian is presented. It is intended to be useful for English-speaking students who wish to study German, French, and Russian chemical literature and also to translators of these languages.

British and German Aircraft; Gale & Polden Limited, Aldershot, England, 1943; 39 pages, 1*s.* 6*d.*

The booklet presents silhouettes of important British and German military aircraft with particulars of their functions, dimensions, and characteristics. To aid in the identification of these aircraft, outstanding features are marked in red.

Wings for Victory, by Roy J. Snell; M. A. Donohue & Company, New York, 1942; 250 pages, $0.50.

An adventure story for boys and girls. Airplanes and flying are the major part of the action.

The War on the Civil and Military Fronts, by Major Gen. G. M. Lindsay; The Macmillan Company, New York, 1942; 112 pages, $1.50.

Delivered as the Lees Knowles Lectures for 1942 at the University of Cambridge, this text deals with two individual phases of waging war: It is a study of armored warfare on the military battle lines and also a study of defense organization on the civilian battle lines.

In the first part of the book the author shows how the tank has revolutionized previous ideas of land strategy, describes its proper use for both attack and defense, and traces the lessons that have been learned in the utilization of armored warfare by different countries. In the latter portion of the book he discusses the implements and methods of proper organization among civilians for the defense of Britain and as an integral part of "total war."

Jobs in the Aircraft Industry, by Albert T. Helbing; Science Research Associates, Chicago, 1943; 48 pages, $0.60.

Number 33 in The American Job Series of "Occupational Monographs," this booklet surveys the different jobs that are available in the aircraft industry. It explains what the jobs consist of and their relation to aviation as a whole. It also tells how to qualify for them, the training they require, their working conditions, remuneration, and prospects for promotion.

Fluid Dynamics, by Richard von Mises and Kurt O. Friedrichs; Brown University Graduate School, Providence, R.I., 1942; 250 pages plus 40-page supplement, $4.00.

Theory of Flight, by Richard von Mises; Brown University Graduate School, Providence, R.I., 1942; 132 pages, $2.50.

Graphical Statics, by Hans Reissner; Brown University Graduate School, Providence, R.I., 1942; 59 pages, $1.50.

Theory of Propellers, by Hans Reissner; Brown University Graduate School, Providence, R.I., 1942; 48 pages, $1.50.

Notes are presented from lecture courses in advanced instruction and research in aviation. The subjects covered include fluid dynamics, the theory of flight, graphic statics, and the theory of propellers. Each subject is developed with the aid of mathematical formulas and sketches. Problems at chapter ends serve to emphasize the text and provide practical applications for the instruction given. A 40-page supplement by Stefan Bergman for the notes on Fluid Dynamics covers the Hodograph method in the theory of compressible fluid.

War Discovers Alaska, by Joseph Driscoll; J. B. Lippincott Company, New York, 1943; 352 illus, $3.00.

The strategic importance of Alaska in this war is told comprehensively by a newspaper correspondent. From a journalist's probing contact with all types of people—admirals and generals, privates and ordinary seamen, territorial officials, and workers on the Alaskan Highway (Aleuts, Eskimos, Indians, and white men)—he gives an eyewitness account of what is happening in the most northern reaches of America. As a bridge to Asia and the nearest jumping-off place for Tokyo, he urges that the potentialities of Alaska as a "second front" be recognized.

Aircraft-Carriers of Great Britain, U.S.A. and Axis Nations; Real Photographs Co. Ltd., Southport England, 1942; 27 pages, 1*s.* 6*d.*

Photographs and descriptions are presented of aircraft carriers of Great Britain, the United States, and the Axis nations. A diagram showing the details of a British aircraft carrier is included.

The Identification of Allied and Enemy War Planes; Real Photographs Company Ltd., Liverpool, England, 1942; 23 pages, 1*s.* 6*d.*

Photographs, outline drawings, and brief descriptions of Allied and enemy military aircraft are presented. Important details of each plane are given in tabular form.

ANC-5 Strength of Aircraft Elements; Army-Navy-Civil Committee on Aircraft Design Criteria, Washington D.C., 1942; $0.35.

Standardization of the requirements of various governmental procuring agencies is shown to be of direct benefit to manufacturers supplying airplanes for both military and commercial use. The requirements for the strength of materials of military and commercial aircraft have for some time been nearly identical. This bulletin on the strength of aircraft elements has been prepared to eliminate the necessity for referring to different bulletins in calculating the allowable stresses or minimum strength of typical structures. Materials covered include wood, steel, aluminum alloy, and miscellaneous metals and alloys.

The Amazing Petroleum Industry, by V. A. Kalichevsky; Reinhold Publishing Corporation, New York, 1943; 234 pages, $2.25.

Written in nontechnical language, this is a résumé of what petroleum is and what it does. The nature of petroleum, its sources, production, transportation, and storage are related. The many products derived from petroleum are described (of which high-octane gasoline, oils, explosives, drugs, and synthetic rubber are but a few).

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Spoken Spanish for Flying Cadets of Our Armed Forces, by Charles E. Kany; D. C. Heath and Company, Boston, 1942; 183 pages $1.00.

The essentials of conversational Spanish are set forth for aviation cadets. The book is divided into three parts, the first part of which deals with preliminary essentials that can be mastered in a few weeks. Part 2 presents dialogues on military training and camp life, and also a military vocabulary. The third part of the book discusses flying instruction and instruments. Although instruction is based on the conversational method, a skeleton grammar is appended for those who wish to consult it.

The Model Plane Annual 1943, by David C. Cooke and Jesse Davidson; Robert M. McBride & Company, New York, 1943; 224 pages, $2.50.

A number of new features have been added to the 1943 edition of *The Model Plane Annual*. There are chapters on opportunities for careers based on model plane activities. The model plane work now being done at the Langley Field experimental laboratories is reviewed. New information is contained in a chapter on model-building tips. A directory chart gives the specifications of 1943 model plane gasoline engines.

Far Eastern War 1937–1941, by Harold S. Quigley; World Peace Foundation, Boston, 1942; 369 pages, $2.50.

The international background of the present war in the Pacific is given in a book in which a record of the Sino-Japanese war from the attack on the Chinese at Lukouchiao on July 7, 1937, to the bombing of Pearl Harbor on December 7, 1941, is presented. The author discusses the economic impact of the West on the structure of government in China and Japan and traces diplomatic maneuvers of the major powers in relation to the conflict. The book surveys American relations with China and Japan and the repercussions of Japan's program upon British policy in the Far East.

Before You Fly; Henry Holt and Company, New York, 1943; 624 pages, $2.75 (special school edition available at $2.00).

The essentials of aeronautics are given in a revised edition of a preflight manual written for those who intend to follow an aviation career. The opportunities in aviation are discussed and the history of aviation is reviewed. Aerodynamic laws are explained. A description of aircraft types and aircraft engines is included. The subject of meteorology is also discussed. Information on aircraft instruments and the problems of navigation are covered under sections dealing with chart reading, pilotage, dead reckoning, radio navigation, contact flying, and instrument flying. The revised edition has been greatly expanded.

General Plastics, by Raymond Cherry; Grosset & Dunlap, New York, 1942; 128 pages, $1.20.

Presenting its information concisely and nontechnically, this book examines the nature and varieties of plastics, relates their history, and studies their machining, fabrication, and applications. The subject matter is divided into three sections: one deals with related information; another, with fundamental operations; and the third, with projects for making plastic articles.

A Racing Plane's Own Story, by Lansing C. Holden; Edith Holden Webster, Boston, 1942; 17 pages, $1.00.

This short story for youngsters is told in personification form. The plane relates its adventures and reactions from its first trial flight until it breaks the coast-to-coast record. Illustrative pencil sketches supplement the text.

Fatigue of Metals, by D. Landau; The Nitralloy Corporation, New York, 1942; 88 pages.

An introduction to the study of the fatigue conditions that limit the stress in metals is presented for designing engineers. In this résumé emphasis is placed on recent developments in combating fatigue by a mechanical counterpoise and by cladding.

The Book of the 'Wellington' War Planes; Real Photographs Company, Ltd., Liverpool, England, 1942; 17 pages, 1*s.* 3*d.*

This booklet is devoted to a description of the British Wellington bomber and how it was developed. Production operations are discussed and illustrated. A diagram shows interior details of the plane.

Freddy and the Perilous Adventure, by Walter R. Brooks; Alfred A. Knopf, New York, 1942; 245 pages, $2.00.

Freddy is a pig; the perilous adventure, a balloon accession. Children will enjoy this story of the events that befell the barnyard occupants when they took to aviation.

Air Trails Model Annual for 1943; Street & Smith Publications, Inc., New York, 1943; 96 pages, $0.25.

The 1943 edition of this annual publication for airplane model builders has been published. Included in the new issue are articles on wartime model building, model wind tunnels, the adjustment of gasoline-operated model aircraft, and the radio control of model airplanes. A chart on model gasoline engine trouble shooting is also presented. There are photographs of completed models and engines, three-view drawings, and construction drawings of models and their component parts.

ABC of Vacuum Power Brakes; Bendix Products Division of Bendix Aviation Corporation, South Bend, Ind., 1942; 132 pages.

Servicing B-K Vacuum Power Brakes; Bendix Products Division of Bendix Aviation Corporation, South Bend, Ind., 1942; 164 pages.

Servicing the Bendix Hydrovac Vacuum Power Braking System; Bendix Products Division of Bendix Aviation Corporation, South Bend, Ind., 1943; 76 pages.

Three manuals on the Bendix automotive vacuum power brake have been issued. The *ABC of Vacuum Power Brakes* presents the fundamentals of automotive vacuum power breaking as exemplified in Bendix B-K products. It is intended as a training manual for students and apprentices. The second manual covers the servicing and testing of B-K brakes with the exception of the Hydrovac, which is the one-unit Bendix system used for vehicles equipped with hydraulically operated brakes. The third manual is devoted to the servicing of the Hydrovac unit.

Index to A.S.T.M. Standards Including Tentative Standards; American Society for Testing Materials, Philadelphia, 1942; 198 pages.

Published as an adjunct to the book of A.S.T.M. Standards and Tentative Standards, this index comprises a ready reference for locating any A.S.T.M. standard in the bound publication of the Society. The index is also of service in ascertaining whether the Society has issued a standard on a specific subject.

Plastics from Farm and Forest, by E. F. Lougee; Plastics Institute, Los Angeles, Calif., 1943; 159 pages, $2.00.

Written for those who know little about plastics, this book describes what plastics are, how they were developed, and the way they are manufactured today. Chapters describe how plastics began with cotton and wood, the manufacture of buttons and cloth from skim milk, and the production of plastics from coal, oil, water, and air. One chapter is devoted to the subject of rubber. Future developments in plastics are discussed.

Silver Wings Against the Sky, by Pearle Moore Stevens; The Naylor Company, San Antonio, Tex., 1942; 72 illus., $1.50.

Three poems in this book of verse have aeronautical allusions. The others, more general in their reflection of present-day life, speak of love, war, and religion.

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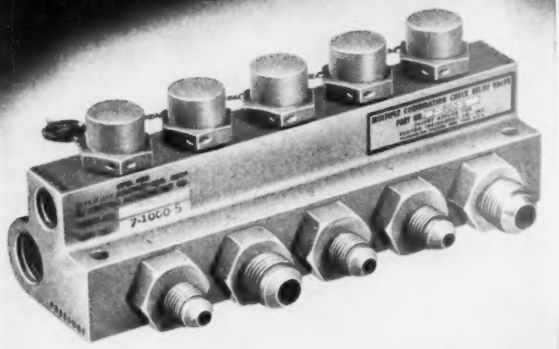

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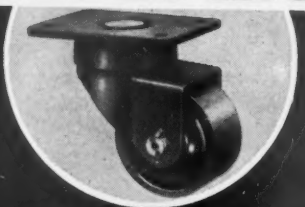

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Aircraft Propeller Handbook, by Karl Hansson Falk; The Ronald Press Company, New York, 1943; 146 pages, $4.50.

A second edition of the *Aircraft Propeller Handbook* is presented. It has been brought up to date and some advanced subject matter that has entered into the propeller field during the last five years has been added.

An Introduction to Celestial Navigation, by William H. Barton, Jr.; Addison-Wesley Press, Inc., Cambridge, Mass., 1943; 44 pages, $0.50.

Written to assist men entering the armed services to become navigators of the sea and air, this introduction to navigation was prepared from notes for the author's classes at the Hayden Planetarium. The book is useful as an introduction to more complete courses. Newer navigation methods now in general use are described.

Women in War, by Herbert Burstein; Service Publishing Company, New York, 1943; 166 pages, $1.50.

A compilation of information on jobs for women in the armed forces and war industries. In addition to listing the war occupations open to women, the book tells how to apply, qualify, and train for different jobs. It describes the work entailed, remunerations, and opportunities for advancement. Among the contents are chapters devoted to the Waacs, Waves, Spars, Nurses' Corps, miscellaneous women services, civil service, volunteer war work, Red Cross, U.S.O., and employment in war factories.

The Elements of Aerofoil and Airscrew Theory, by H. Glauert; The Macmillan Company, New York, 1943; 228 pages, $3.50.

An American edition of this book on the theory of airfoils and airscrews has been issued. The subject is presented in a form suitable for students who do not possess a previous knowledge of hydrodynamics. A brief introduction to those aspects of hydrodynamics which are required for the development of airfoil theory is furnished. Following chapters deal with the lift of an airfoil in two-dimensional motion, the effect of viscosity and its bearing on airfoil theory, and the theory of airfoils of finite span. Concluding pages are devoted to the development of airscrew theory. Complex mathematics has been avoided as much as possible.

Building Model War Planes for the Army and Navy, by Emanuele Stieri; Duell, Sloan and Pearce, New York, 1943; 89 pages, $2.50.

Basic plans and specifications are given for 60 model planes prepared by the Army and Navy in cooperation with the U.S. Navy Bureau of Aeronautics and the U.S. Office of Education. Official Army, Navy, and Royal Air Force photographs of each of the planes are shown. In addition, complete assembly plans, profile and silhouette views, and basic data on the planes are presented. The book shows the progressive steps in the construction of the models. A supplement contains full-size construction patterns of the models and is priced at $1.25.

(*Continued from page 16*)

Conclusion

The author has attempted to show that megacycle energy is a prerequisite for uniform thin case hardening. It was shown that by restricting heat to the surface layer of the work increased speed and lower energy cost resulted.

Freedom from distortion or warpage of the work was directly associated with high-speed thin case hardening. This fact, together with freedom from scaling made final machining prior to heat-treat feasible. Since the heat gradient between surface and interior is high, self-quenching of the surface is usually possible and will result in a saving of space and equipment. The space requirement of a vacuum tube oscillator is small. Its power supply can be located at a remote point, and its work load can be either located at the oscillator or coupled to it from a distance by means of a grounded concentric line. Many parts of nominal size can be made fully automatic as to loading, heat-treating, and ejection. The possibility of the heated surface layer tempering an adjacent interior layer and thus reducing its tensile strength was investigated. No measurable loss of hardness was found. This was attributed to the short time during which the interior layer had been exposed to high temperature. The temperature distribution curves for a particular piece which were shown illustrate that unless the heating time is restricted to 1.0 sec. or less, interior layers will reach undesirably high temperatures.

(*Continued from page 29*)

attempting extremely deep draws. This allows the sheet to be drawn over the female draw ring radius at its maximum plasticity but to be chilled immediately by the punch, thereby increasing its tensile strength. This accounts for the 60 to 70 per cent single draw possible in hot forming as against the theoretic 50 per cent reduction in cold forming processes.

Sizing

The above sequence of operations results in a duplication of parts drawn to reasonable tolerances despite the fact that fabrication has been carried out at elevated temperatures. Aircraft wheel hub caps, 4.75 in. in diameter, have been drawn to a tolerance of ±0.003 in. or about 0.1 per cent of the diameter; however, these same parts have been sized cold to a tolerance of ±0.0015 in. The cold sizing die consists of a punch and draw ring both turned slightly undersize to allow for springback. The piece to be sized is deliberately drawn large, is cooled, and is placed cold over the cold sizing punch. The part is then forced completely through the draw ring, the springback being sufficient to strip the part from the punch on the return stroke.

Conclusion

The foregoing discussion depicts the progress that has been made to date on the plastic working of magnesium alloy sheet. Constant research both in alloying and fabricating processes are daily opening up new fields for this lightweight material. It is evident that magnesium alloys can be formed into the desired shapes if the designer and press-shop man will supplement their knowledge of forming operations with the information given, keeping in mind the physical limitations of the material and the technique necessary.

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BELL *Aircraft*

PACEMAKER OF AVIATION PROGRESS

House Organs and Catalogues

Improving Production Procedures

Vega Production Engineers Simplify Operating Methods. Robert A. Trumpis and Nels Irwin. Details are given on the purpose, organization, and operation of Vega's Production Engineering Department. In each production department, working in cooperation with the foreman of that department, a group of production engineers is authorized to execute changes in operating methods. Their work includes: (1) planning of tools; (2) writing of tool orders for correction of tools to shop practice requirements; (3) reconciliation of shop practice requirements with Engineering call-outs; (4) processing of all departmental work in coordination with the shop supervision to establish accurate disbursement of parts; (5) correction of work place arrangement to conform to the departmental conditions such as limitations of personnel, area of department, schedule requirements, and material flow; (6) establishment of smooth material flow and elimination of backtracking; (7) establishment of measured work stations, requiring time analysis and personnel requirements; and (8) establishment of ship serials at which changes could be installed commensurate with the schedule requirements. The improvements achieved by this organization over former methods are exemplified by an account of a typical procedure before and after its establishment. *Lockheed-Vega Aircraftsman*, February.

Production Illustrations

Assembling Planes from Picture Books. An article is presented on the use of production illustrations in aircraft assembly. To teach unskilled workers how to read highly technical blueprints, Boeing is employing illustrations drawn from blueprints. The way assembly operations are simplified by reducing them to pictures is described. *Boeing Contact*, March.

Parachute Manual

The Switlik Parachute Company, Trenton, N.J., has published a 47-page manual on the Switlik safety chute. The principle of operation of this chute is explained in the opening pages of the manual, and information is given on the six essential units of the chute. Other sections of the booklet cover the use of the chute, inspection and maintenance, instructions for packing, the adjustment of the harness, and how to use the Switlik chair chute.

Aircraft Repairs

Training Doctors for Wounded Bombers. This is a description of how men are trained for the servicing and maintenance of Liberator bombers of the Army Air Forces. It is explained that at Camp Consair and similar camps men are selected who have shown unusual aptitude in basic mechanics and are turned into specialists on Liberators. *Plane Talk*, April.

Helping to Build the B-17

Sub-Assembling the Flying Fortress. Some data are presented on the building of B-17 bomber parts by the Bell Aircraft Company. The procedure of subassembly is outlined briefly and reasons why the manufacturers of the Airacobra were assigned to make these parts are given. *The Bellringer*, April.

Guide on Motor Controls

A guide to the selection and application of commonly used motor controls has been issued by the General Electric Company. This 16-page manual is designated as GEA-4015. The fundamentals of motor control are presented with the aid of illustrations and explanatory diagrams. Starting with a simple analysis of the functions of controls, the booklet next describes the basic control parts of industrial devices. This is followed by an explanation of how to select the correct control. The balance of the manual is devoted to a progressive breakdown of standard controls available. Information on their operation and functions is given and enclosures for industrial control devices are described.

Catalogue of Welding Equipment

The various types of spot welders manufactured by the Eisler Engineering Company, Inc., Newark, N.J., are described in an illustrated catalogue. Detailed specifications and information on the manufacturer's electric welding equipment and transformers are presented. Air-operated spot welders are also described.

Index to Airplane Patent Digest

The Index Number for Volume XIII of the *Airplane Patent Digest* for the twelve-month period terminating December 31, 1942, has been issued. As in the case of indexes for previous years, the names of the patentees in the Patents and Designs lists, as well as the registrants in the Trade-Marks list, have been arranged in the order of the first significant character or word of the name. Whenever a patent has been taken by joint applicants or by an assignee or other representative, the same has been cross-referenced under all parties or record, so that by referring to the name of any company or individual the holdings of the respective party at the time of the issue of the patents may be readily ascertained. The title page and index number both conform to the dimensions of the *Digest* in order that the publication for the entire year may be bound to become a permanent record for reference purposes.

The Association has also published Volume XIV Number 3 of the *Digest*, covering patents numbered 2,309,682 to 2,310,887, inclusive. *Manufacturers Aircraft Association, Inc.*

Hot Pressing

In Bulletin No. 3 published by The Resinous Products & Chemical Company, hot pressing studies of Amberlite PR-14 are presented. The object of the studies was to determine the limitations in the use of walnut-shell flour and alcohol for reducing the permissible assembly time for bonding Amberlite PR-14 in flat press plywood without causing excessive resin flow. The data presented are intended to serve as a guide to users of Amberlite.

Women Ferry Pilots

Lady-Bird. Keith Eagan. An article on the Women's Auxiliary Ferrying Squadron tells about the girls who ferry warplanes from factory to flying field, the duties they are performing, and the life they lead at the New Castle base. *Shell News*, March–April.

Cable Connectors for Aircraft

A manual on the construction, application, and maintenance of Cannon multiple contact cable connectors for

aircraft electrical circuits has been issued by the Cannon Electric Development Company, Los Angeles, Calif. The first section of the manual is devoted to production operations in the factory. This is followed by a section illustrating and briefly describing some commercial and combat planes in which Cannon connectors are used. A third section of the manual covers wiring and servicing. The final pages of the book are devoted to a classification of the various types and shapes of Cannon connectors used in aircraft.

Aircraft Alloy Steel Handbook

Aircraft Alloy Steels is the title of a recent combined special stock list and data book published by Joseph T. Ryerson & Son, Inc. The booklet was designed as a practical guide to aircraft steel stocks, prices, sales limitations, and specifications. It is available to all buyers and technical men in the aircraft and aircraft parts manufacturing industries.

In addition to the listings of available steels, the publication furnishes a condensed version of the Aeronautical Material Specifications (AMS) which pertain to steel. These AMS specifications are presented in brief tabular form to serve as a guide for the identification of the essential requirements of each specification. The Army-Navy Aeronautical Specifications (AN-S and AN-T), which cover the new NE steels acceptable to the aircraft industry, are also condensed in tabular form.

LAUXITE RESINS
To Meet Specification:
AN-NN-P511b
PHENOL RESIN
Lauxite PF10
MELAMINE RESIN
Lauxite MX
Lauxite MU
Lauxite 9-2C plus
25OL Hardener
•
AN-G8
UREA RESIN
Lauxite 77X
Lauxite 947MX
•
CS-45-42
PHENOL RESIN
Lauxite PF4

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I. F. LAUCKS, Ltd., Granville Island, Vancouver, B. C.
HERCULES-LAUX-MERRITT, Ltd., Stanbridge, Quebec

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V-Belt Catalogue

Information on Veelos adjustable V-belting is presented in a catalogue offered by the Manheim Manufacturing & Belting Company, Manheim, Pa. An outline is given of the sequence of operations required to take this link V-belt apart, which only requires the use of a screw driver, and of the steps necessary to couple the belt together again, which is done without the use of tools. The procedure followed in installing the belt on the drive is described with the aid of illustrations and typical applications of the belt are shown. Engineering data and a sample calculation for determining the necessary size of a drive are presented. A table gives the proper length of Veelos belt to use.

Instrument Flying for Pan-American Pilots

Rangers Keep the Baby Clippers Flying. This article deals with Pan American Airways' program for teaching and checking pilots in instrument flying. Given in four Ranger-powered Grumman Widgeons flying out of La Guardia Field and confined to a 15-mile radius around Portchester, N.Y., the courses serve a twofold purpose: besides giving P.A.A. junior pilots an opportunity to prepare for instrument rating and progress to Airline Pilot's certificates, they afford the facilities for seasoned pilots to keep abreast of the latest developments and techniques in flying. Part of the article is devoted to an account of how the Widgeons are maintained. *The Pegasus*, April.

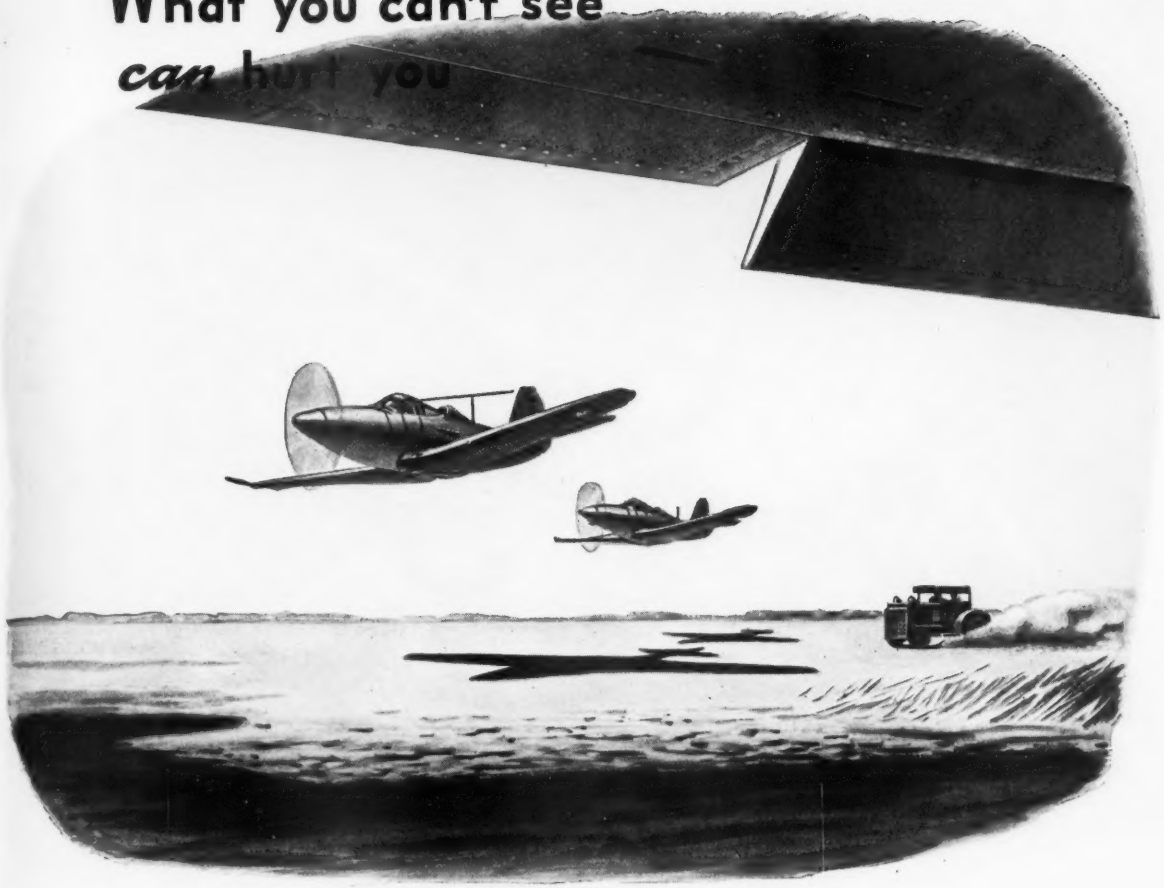
Tool Saver

Hot Tip Saves Tools. H. G. Brandt. A method of repairing broken milling cutters is described. This method utilizes an atomic hydrogen arc welder. It is claimed that after the welding process, the tensile strength of the reworked cutter is equal, if not superior, to that of a new tool. *Lockheed-Vega Aircraftsman*, February.

National Aircraft Standards Sources

A list has been prepared from information on file with the office of the national chairman of the Committee, covering the trade names and makers of various accessories and supplies. The Committee has also issued National Aircraft Standard 205 on recessed-head screws. *National Aircraft Standards Committee.*

What you can't see *can* hurt you



Aero Quality LUMARITH protects against the invisible

"Blistering heat" can blister! And even the clear cold of the upper air does not give aviators protection against sunburned eyes. The invisible rays of the sun, in the ultra-violet band, can deliver a biting burn to airmen during their long flights.

That is why Aero-Quality Lumarith transparent plastics for aircraft is specially processed (light stabilized) to intercept the sunburning rays—and, to improve weathering qualities at the same time . . . *the invisible conquers the invisible!*

Lumarith plastics have been doing a lot of flying for the Armed Forces. Control knobs, first-aid kits and other molded parts from Lumarith molding materials...gauges from Lumarith tubes . . . transparent canopies and other panels and parts from Aero-Quality Lumarith sheets. In all these applications, the high impact strength of Lumarith contributes military stamina, as it does in hundreds of ground uses from telephones to tool handles and gas masks to grommets.

Celanese Celluloid Corporation, 180 Madison Ave., New York City, a division of Celanese Corporation of America Sole Producer of Lumarith* and Celluloid* plastics. . . . *Representatives:* Cleveland, Dayton, Chicago, St. Louis, Detroit, Los Angeles, Washington, D. C., Leominster, Montreal, Toronto, Ottawa.

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The fire-power of our new Navy is not measured in terms of tonnage or turrets alone. Every big gun afloat is backed aloft by a potent dive-bomber capable of blasting the enemy with pin-point accuracy. Such long range extension of fire-power stems from Navy pioneering of 24 years ago. Its effectiveness confirms the strategy of its originators.
BREWSTER Blasters
BUCCANEER AND BERMUDA DIVE BOMBERS
NAVY F3A FIGHTERS

Airplane Production

An Airplane is Born. Palmer Wentworth. Part VIII in a series of articles on the design and manufacture of an airplane treats of the actual fabrication work involved. A typical part—a wing rib—is followed through the various major steps until it becomes a part of the airplane. Since the article is brief, the explanation is necessarily a general rather than a detailed one. Emphasis is placed upon the desirability of planning fabrication processes so that there is a steady flow of materials through the factory at all times with a minimum of back tracking. *Ryan Flying Reporter*, March 26.

Catalogue on Electric Contacts

A 36-page illustrated, two-color catalogue, issued by the Callite Tungsten Corporation, Union City, N.J., discusses the design, manufacture, and application of electrical contacts of silver, platinum, tungsten, molybdenum, and other metals and alloys. This catalogue covers types of contacts, their physical size and shape, and the particular applications to which each metal and alloy is best suited. It also illustrates and gives specifications of typical standard contacts designed and manufactured by Callite. The catalogue is designated by the company as No. 152.

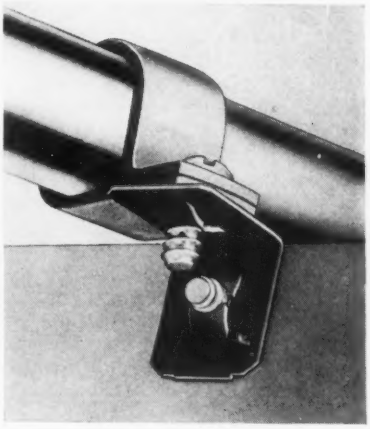
Guns for Airplanes

Ordnance Fills Those Orders. This is an article on the Ordnance Division of Bell Aircraft Company. It tells something about the division's purpose, activities, record, and production capacity. Designed for installation in fighters, bombers, and flying boats, 39 different types of guns are made by Bell Ordnance. These range from manually operated mounts for single 30-caliber guns to big, hydraulically operated, remote control mounts for larger guns. The article includes data on an automatic screw machine used in the Ordnance Department. *The Bellringer*, April.

Aeronautical Standards

New sheets have been published for inclusion in the S.A.E. Aeronautical Standards files. These include: AS 7A on cylinder-dehydrator plugs; 9A on cable attachments; 45A and 53A on generator mounting pads and drives; 75 on deicer positioning pegs; 130 on tube bending radius; 131 on oil inlet and outlet pads; 134 on hexagon bolt heads; and 135 on flat fillister bolt heads.

Aeronautical Information Report No. 1 has also been issued on AN Standard Series, Air Corps 811 Series, and NAF 3105100 Series fittings, as well as *Aeronautical Information Report No. 3* on "Survey of Operating Practices with Propeller-Ice Elimination Equipment." *Society of Automotive Engineers.*



Tinnerman Products fastener for aircraft conduit and piping.

Manual of Fastening Devices

Information on Parker-Kalon fastening devices is presented in the form of an indexed manual of engineering standards. Specifications and the type numbers of the screws manufactured by this company are given. There is a list of the types of screws to use for particular purposes. *Parker-Kalon Corporation*, New York.

Electrical Standards for Small Motors

The Dumore Company, Racine, Wis., manufacturer of fractional horsepower motors and precision grinders, has prepared for distribution a 28-page illustrated booklet on *American Electrical Standards for Fractional Horsepower Motors.* The publication covers standards approved by the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, the National Electrical Manufacturers' Association, Underwriter's Laboratories, the United States Department of Commerce—Bureau of Standards, the United States Navy, and the United States War Department. Definitions of all terms and motor parts, speeds and duty classifications, motor types and standards are included in the pages of this pocket-size handbook.

Machine Lighting Units

Swivelier machine lighting units, manufactured by the Reliance Devices Company, Inc., New York, are described in an illustrated catalogue. The swivel base and the socket each have a wide range of movement. The socket adjusts in a 90° vertical range and rotates 350° horizontally. The arm in the base also has 90° vertical adjustment and 350° horizontal range. Constructional features of the sockets are shown by means of a diagram. How these units are used to provide more light for the operators of industrial machines is explained.

Engine Flight Tests

On Flight Testing Engines. An outline of engine flight test routine, some of the problems involved, and the data established by such a test. It is shown how the pilot, testing engines, centers his attention about the nose section of the plane. Although his chief concern is the pulse of the engine under the cowl, he must also watch for any change in the airplane's flight characteristics which may result from engine operation. *The Pegasus*, April.

Die Cushion Service Manual

Instructions on the installation and servicing of pneumatic die cushions are given in a 28-page catalogue published by the Dayton Rogers Manufacturing Company, Minneapolis, Minn. The catalogue contains information on the construction, operation, and care of pneumatic die cushions. It describes installations used in connection with deep-drawing operations, pressed pad control on forming dies, and stripper pad control on compound blanking and piercing dies.

Oven Heat Control Equipment

Catalogue 325, issued by the Precision Scientific Company, Chicago, contains 48 illustrated pages pertaining to "Precision"-Freas constant temperature control cabinets. The company's standard models are described and photographs show constant temperature cabinets and baths built to specifications. Standard cabinets include electrically heated ovens for laboratory drying operations, plastics, preheating, conditioning, rubber aging; sterilizers, incubators, paraffin embedding ovens; low temperature cabinets, humidity control cabinets; steam-heated explosion-proof cabinets, vacuum ovens and combustion-tube furnaces for laboratory use. The catalogue also contains general information on mechanical and gravity convection heat transfer.

Planning

A Bomber is Born. This part of a continued article on the design and manufacture of a Martin bomber is concerned with the assembling of materials and tools for the job and the scheduling of their use. With the activity classified under the three general heads of materials, tools, and production schedule, the fundamental steps in the planning procedure are related, but no attempt is made to describe in detail what every particular branch of the manufacturing organization does. *The Martin Star*, April.

Subcontracting Program

Outside Production. John P. McCarthy. Details of Lockheed's subcontracting program are presented in an article telling how suppliers are pouring a steady stream of parts into the Lockheed production line. The duties and activities of those who are carrying the responsibility of this program are outlined. *Lockheed-Vega Aircraftsman*, March.

Colloidal Graphite

Acheson Colloids Corporation, Port Huron, Mich., has recently published a new 12-page illustrated bulletin, No. 430-B, on the application of "dag" colloidal graphite to modern industry. The bulletin describes the physical and chemical properties of "dag" colloidal graphite and how it differs from other forms of graphite, especially with regard to particular size, which is of importance to the industrial application of this material.

It discusses the reasons for liquid carriers and how dispersions are controlled. The subjects of "dag" colloidal graphite as a lubricant for running-in engines, for high temperatures, for impregnating porous bodies, for use as a parting compound, and for electrical applications are treated. The booklet summarizes the standard colloidal and semicolloidal dispersions and illustrates a number of typical applications.

Alloy Metals Finding List

A booklet of 16 pages constitutes a finding list and provides condensed information on the specifications, characteristics, trade names, and producers of numerous alloy metals. It includes a key index by which the characteristics and specifications can be readily located and the recommended metals and their sources can be determined. *Hobart Products Company*, Troy, O.

Aircraft Chain Data Book

The Aircraft Chain Division of Link-Belt Company, Indianapolis, Ind., is offering to aircraft engineers a new 36-page loose-leaf engineering data book No. 1825 giving information needed when designing chains and sprockets for aircraft app ications.

Covering precision-built aircraft chains of both roller and silent types, this data book emphasizes the new aircraft silent chain designed to provide the maximum in smoothness of drives on controls, with the least frictional load for operation of these controls.

In this new data book No. 1825, the aircraft engineer will find necessary dimensions of chains and wheels for both types of chains, tensile strengths, weights per foot, details of end fasteners, chain elongation curves, lists of standard sprocket wheels, information on how to calculate chain centers and length of chain required, lengths of chain that will couple, a metal hardness conversion table, and convenient formulas.

Experimental Flight

Lockheed's Experimental Flight. D. D. Shomer. The importance of the experimental flight department is described and some of the work that is being carried out in this branch of the Lockheed organization is outlined. *Lockheed-Vega Aircraftsman*, March.

Growth of an Aircraft Company

The Northrop Group. The second part of an article on the history of the Northrop company and the planes it has produced. This installment, describing the beginning of the company's operations and its first undertakings, brings the story up to the point where manufacture was started on the N-3 patrol bomber. It designates the men responsible for Northrop's organization and its earliest employees. Some of the company's first problems are noted, two Northrop developments are mentioned—the Northrop Flying Wing and the "Heliarc" method of welding magnesium. *The Norcrafter*, March.

Auburn CERAMIC SPARK PLUG CONNECTORS

The Auburn Ceramic Connector is a certified product that has been officially approved and accepted.

It combines high dielectric and heat-resisting qualities — with full assurance against carbonization, carbon-tracking and moisture absorption. Maintains constant contact.

Made in two sizes as illustrated.

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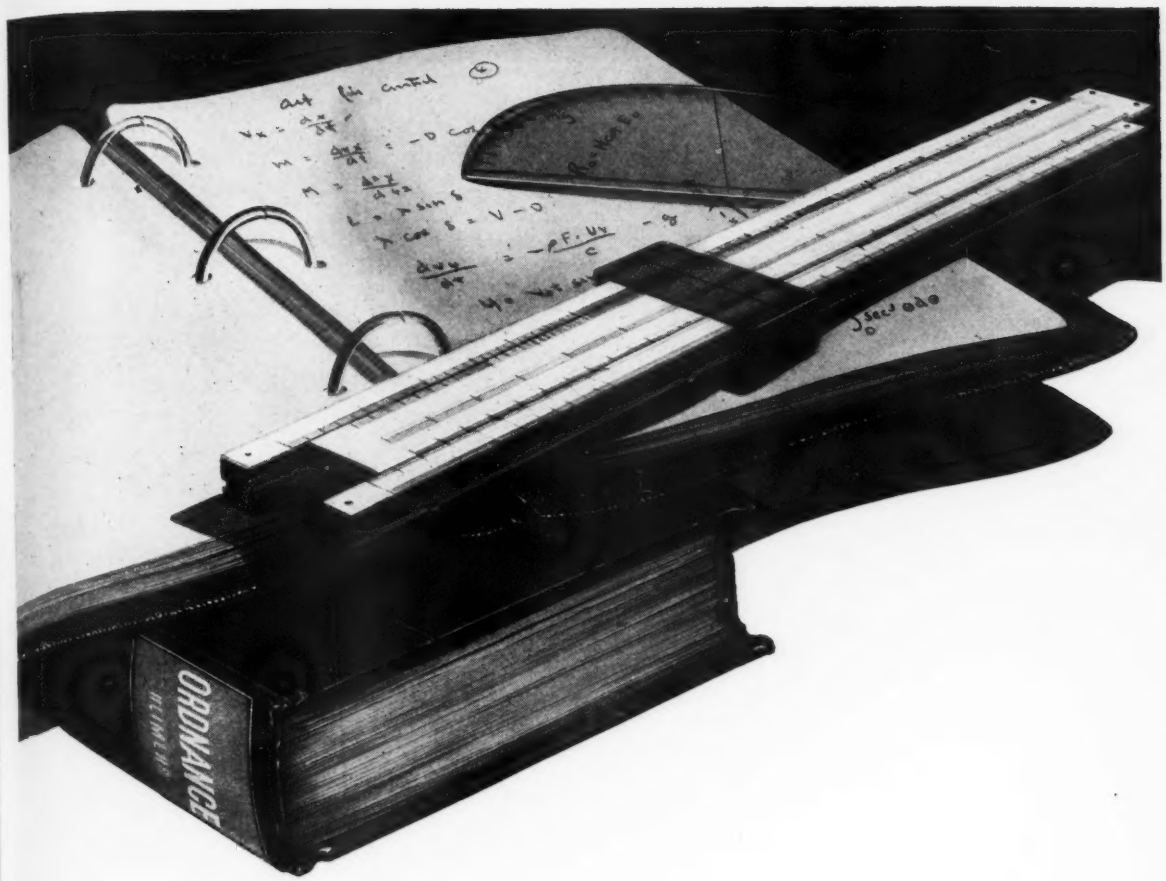

What's a cotangent got to do with ack-ack?

PLENTY. So have sines, cosines, squares and square roots, differential equations, and integral calculus.

For the accurate firing of anti-aircraft batteries depends wholly upon the science of mathematical calculations that must be made fast—faster than a score of the most brilliant mathematicians could do it!

To solve these problems—to make the ack-ack of the United Nations deadlier—Westinghouse engineers are assisting in the development of an improved "electric brain" that makes the necessary lightning-like calculations.

The firing control—known as the "computing director"—not only *locates* the exact position of the target as it twists and dodges through the sky. It also *calculates* where the enemy plane will be by the time the shell has traveled 10,000 or more feet into the air—all in a matter of seconds.

And that's not all. The computing director makes instantaneous corrections for drift, air density, wind conditions, and gun muzzle velocity. In addition, it calculates the fuse setting on the shell—so that the burst will occur at the *calculated position* of the enemy plane.

Westinghouse is making hundreds of other weapons for victory such as: guns, shells, radio equipment, instruments, electric motors and generators, and propulsion equipment for our giant battleships and rapidly growing merchant marine. And delivering these war materials faster than ever!

We are proud of the way Westinghouse "know-how" is adding day-by-day to America's tremendous striking power—on land, at sea, and in the air.

Westinghouse Electric & Manufacturing Company, Pittsburgh, Pennsylvania.

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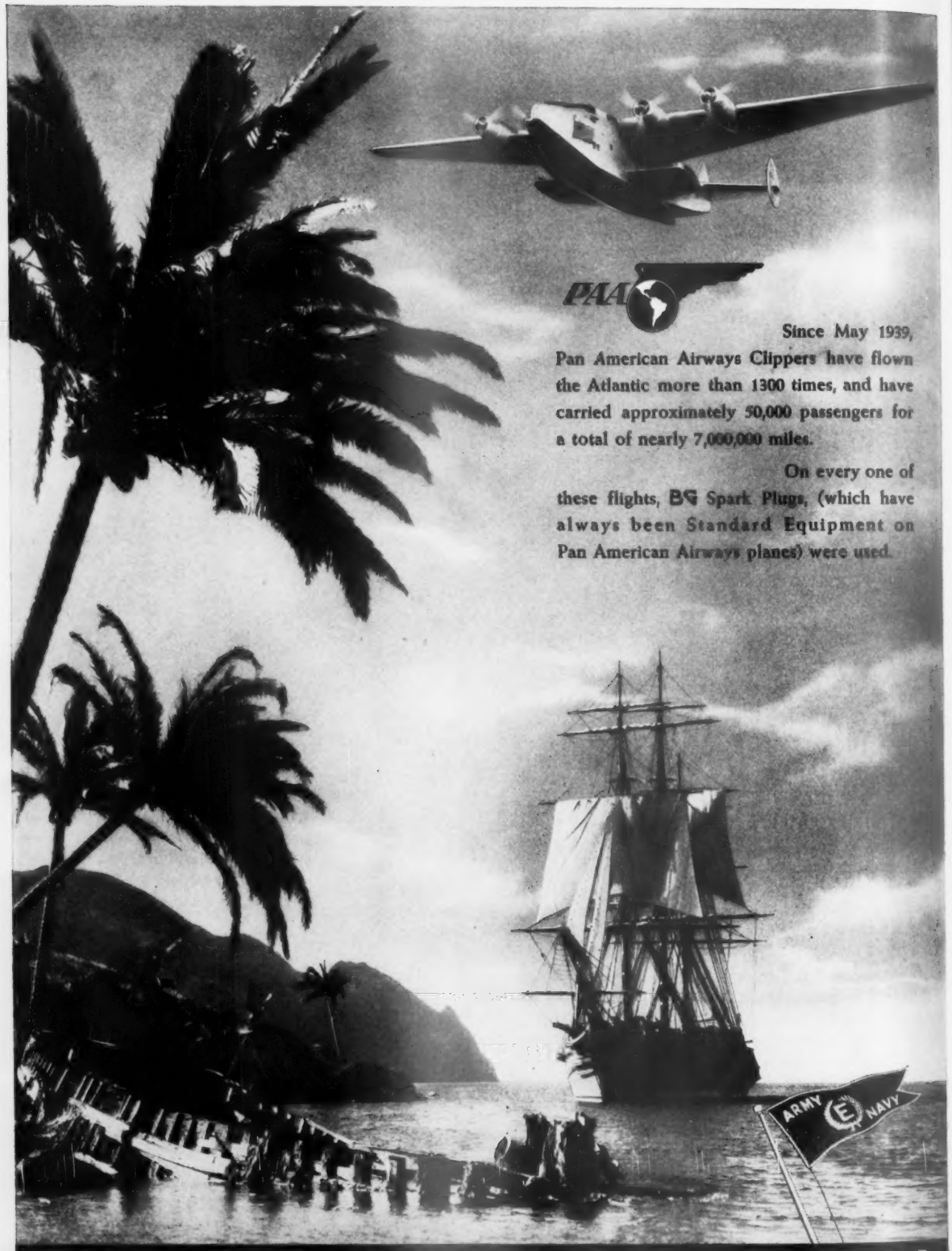
PAA
Since May 1939, Pan American Airways Clippers have flown the Atlantic more than 1300 times, and have carried approximately 50,000 passengers for a total of nearly 7,000,000 miles.
On every one of these flights, BG Spark Plugs, (which have always been Standard Equipment on Pan American Airways planes) were used.
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Contractors to the United States Army, Navy and Coast Guard and Aircraft Engine Builders
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Bulletin on Hard-Facing Material

Bulletin No. 153, describing "No-Wear" hard-facing material, has just been released by the Callite Tungsten Corporation, Union City, N.J. This bulletin describes the advantages and physical characteristics of the material. Methods of application and typical uses for the material are also given.

Pioneer Air-Mail Flight

A World Airline Was Launched. The writer recalls the details of a trip in which he states Pan American Airways' first contract air-mail load was delivered. Piloting a plane for West Indies Aerial Express, he picked up the mail at Key West and delivered it at Havana for P.A.A. The plane was a Fairchild FC-2 seaplane with a Wright J-6 engine of about 200 hp. *The Pegasus*, April.

Plant Equipment

A 50-page ring-bound bulletin issued by the Industrial Department of the General Electric Company describes the various types of electric equipment available for aviation-gasoline plants. Included is apparatus developed to meet special conditions and the needs of processes used in these plants.

The booklet, which is designated as GES-3147, is divided into three main sections—power generation, power distribution, and power utilization. Turbine generators, switchgear, load-center unit substations, cable, mechanical-drive turbines, different types of motors and controls, and cycle timers are a few of the electrical accessories listed.

Catalogue on Tackers and Staplers

A catalogue is presented covering the line of tackers and staplers manufactured by A. L. Hansen Manufacturing Company, Chicago. A complete description of these automatic tackers is given. The unit is loaded with a quantity of tacks and is manually operated. A number of models for different industrial purposes are illustrated. A table giving the dimensions of each model is furnished.

Spray Equipment Catalogue

Eclipse spray equipment is described in a 32-page catalogue issued by the Eclipse Air Brush Company, Inc., Newark, N.J. Specifications and data are furnished on spray guns, pressure tanks, agitators, and accessories. The Eclipse method of coating parts is explained.

School for Armorers

War Production Service Department of Oldsmobile Division Graduates 3,500 Student Armorers in First 11 Months. Second in a series of articles on the Army-Navy training program being conducted by various General Motors divisions, this one describes the Aircraft Armament Training School of the Oldsmobile Division. Reporting the number of men the school has trained in its first eleven months, the article also records the theory of instruction (correlating classroom and workshop), teaching and billeting facilities, and curriculum. It is noted that, in addition to its permanent training school, the Oldsmobile Division conducts mobile field schools for the military services to assist in the proper servicing of guns, observe firing tests, and diagnose and correct malfunctions of Oldsmobile-constructed guns. *G-M Folks*, March.

Antiaircraft Searchlight Manufacture

New Precision Methods for Searchlights. A description of how the Sperry Gyroscope Company applies new production techniques in the manufacture of 60-in. antiaircraft searchlights, facilitating the substitution of steel for the scarcer aluminum. The article includes data on production design changes, new assembly methods, and anticorrosion treatments. *Sperryscope*, March.

Plywood Molding Technique

Bag Molding and the Coated Core Technique. John Stephan. The bag molding method of forming plywood aircraft parts is discussed. The writer points out that the increased use of this process is because of the fact that it is particularly suited to the forming of the complicated curved surfaces so prevalent on aircraft. Different methods of transferring the heating medium to the veneers being bonded are described.

The length of time that an assembly must be kept under heat and pressure is considered. The characteristics of the various types of adhesives are discussed and the advantages of the coated core method are outlined. *Construction Glues*, January-February.

Control Department

Application of Dimensional Control. The function and operation of dimensional control are explained. Its two primary organizational purposes are listed as the integration of a total design and production program and the exercising of a technical control over the engineering and tooling groups. A basic organization chart shows the place of this department in the total manufacturing setup. *American Aviation Sky-Gest*, March.

Booklet on Arc Welding

A 42-page booklet titled "Factors Affecting Increased Welding Production," has been published by The Lincoln Electric Company, Cleveland, O. The booklet is divided into 15 sections covering the various specific phases of arc welding. It is illustrated and contains charts and tables for use in choosing the correct electrode, applying the most suitable welding technique, and estimating the cost of welding jobs.

Survey of Transportation

Transportation in Wartime. Reviewing developments in air transportation, the article shows that the air lines, at the time of the entry of the United States into the war, had a total of 324 commercial planes in operation. The War Department took over approximately 50 per cent of these planes for military personnel and cargo, the study explains, but with improved schedules and increased load factors the air lines were able to maintain substantially the same volume of passenger traffic and to score increases in mail and express traffic.

Increased availability of planes for private use, lower prices, the expanded network of large and small airfields, the release from the armed forces of large numbers of pilots, technicians, and others experienced in the use of aircraft, all point to greatly expanded use of private civil aircraft. It is stated that the private airplane will undoubtedly compete with the automobile for long-distance travel. The helicopter and the autogiro may compete with the automobile for medium-distance travel, especially when there are natural obstacles, and with the airplane when convenient airfields are not available at one or the other terminal. *The Index* (The New York Trust Company), March.

Electronic Contactors for A.C. Resistance Welding

G-E ignitron contactors for fast, accurate power switching of a.c. resistance welding machines are described in a new, illustrated 8-page bulletin, GEA-3058B. The bulletin outlines the features of these electronic contactors and describes and illustrates their construction, installation, and operation.

The publication also illustrates three standard electronic contactors—the 150-, the 300-, and the 1,200-amp. sizes. In addition, it lists the four principal ways in which these contactors may be used to best advantage for the control of a.c. resistance welders. *General-Electric Company.*

Craftsman? Yes Sir! This American Bosch girl is a highly skilled specialist — — modern interpretation of the New England tradition

Here Arctic and Equator are only Seven Miles Apart

THERE may be only seven miles or so between a plane's service ceiling and the burning desert floor . . . but the temperature spread is as great here as it is between the North Pole and the steaming tropics. That calls for flying equipment that can take the gaff at 70° below and — only minutes later — 150° above.

American Bosch magnetos in U. S. planes are ready to take this punishment from the thermometer; they deliver rich high-tension sparks at the *right* split-second of time . . . now to altitudes far higher than ever before.

Superior American Bosch *design* is backed by similarly superior *production.* Thousands of units move swiftly into service, thanks to our large staff of *specialist* craftsmen . . . many of them relative youngsters who — through engineering, planning, training, and tooling — have gained the skill to do *few* operations *extremely well.* That's the modern American Bosch development of the New England tradition.

In research, design, and production — war or peace — American Bosch serves all branches of the internal combustion engine industry.

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AVIATION AND AUTOMOTIVE ELECTRICAL PRODUCTS . . . FUEL INJECTION EQUIPMENT

MODERN CRAFTSMEN IN THE NEW ENGLAND TRADITION

From the Industry

Releases are printed as received from companies and other aeronautical organizations and the responsibility for the accuracy of all statements is therefore not assumed by the Aeronautical Engineering Review.

Acetylene Generator

Although new to the United States, the Adler acetylene generator has been made and sold in Europe for many years. The generator is claimed to have four important features, summarized as: (1) automatic control through the displacement method; (2) the generator uses "lump" carbide $3^1/_2$ by 2 in.; (3) the automatic control feature eliminates hand operation of pressure and safety valves; (4) it can be used with any torch, high or low pressure, for cutting and welding and for soldering without oxygen. Adler Manufacturing Company, Milwaukee, Wis.

Portable Degreasing and Cleaning Tank

Dipmaster, Jr., is a portable, insulated electrically heated dipping tank. It has a normal capacity of 12 gal. and is equipped with a heating element located inside on the bottom of the tank where it is completely submerged, giving an average heating time of $1^1/_4$ hours from a cold start to boiling point.

Standard equipment furnished with the Dipmaster, Jr., includes two dipping baskets, each measuring $11^3/_4$ in. long by $11^3/_4$ in. wide by 8 in. deep; a bimetal thermometer registering a temperature range of 100°–600°F.; a thermostatic control of the rigid, shockproof type, equipped with a dial and knob to shut off the heating element manually and to maintain automatically any desired temperature between 100°–550°F.; and a drawoff cock for emptying the tank.

Larger stationary models of the Dipmaster, Jr., are available, ranging up to 600-gal. capacity. These are heated by kerosene, city, or liquefied gases, with removable immersion tube heating units in the tank. Aeroil Burner Company, Inc., West New York, N.J.

Assembly Tool Kit

Aeroquip Corporation, Jackson, Mich., is offering a new assembly tool kit for use with Aeroquip standard hose lines and detachable fittings. This kit is designed to facilitate rapid assembly and maintenance work at manufacturing plants and bases, as well as quick emergency field service. Because of the Aeroquip detachable principle whereby hose-line replacements can be made by simply cutting the desired length of hose, detaching the fittings from the old line and assembling on the new line, the assembly kit is expected to expedite this feature.

The kit contains a wood clamp for seven standard tube sizes. Seven mandrels and adapters for inside diameter sizes from $^1/_8$ to $^5/_8$ in. are provided to assemble both short and long male and swivel type Aeroquip connections and to accommodate both AC and AN standard threads.

Results of Pooling

Warplane Production is the title of a bulletin published by the Aircraft War Production Council, Inc., on the occasion of its first anniversary. It reviews the results of the Council's method of free interchange of scientific skill, production methods, materials, and facilities between the eight West Coast aircraft manufacturers who comprise its membership. It is shown that deliveries of the eight member companies have increased, by weight, 295 per cent between November 30, 1941, and February 28, 1943. This figure reflects not only an overall production increase but an intensified concentration on the heavier type of plane. The poundage delivery increase of 295 per cent was achieved with an increase of dollar delivery value of 210 per cent. Improved and more skillfully coordinated production methods helped to reduce the production cost. The increase of direct man-hours in plane production rose only 53 per cent.

Detailed information on all production devices enumerated in the bulletin is available from the Council to authorized manufacturers of war goods. The Council also places at the disposal of manufacturers, through its Information Exchange Division, an index of technical aeronautical articles, more than 100 training films, and a compendium of general war industy information.

The bulletin reviews in considerable detail the accomplishments of the Council in its first year of operation.

Conveyers

A 6-page colored folder contains illustrations and brief descriptions of numerous installations of conveying apparatus being used in war-production plants. Among the applications shown are conveyers for handling shell billets, forgings, and shells in process of machining and painting. Other types of conveyers shown are for handling airplane wings and for towing trucks loaded with ordnance materials. Elevators and other apparatus to facilitate the handling of war materials are also included. The Alvey-Ferguson Company, Cincinnati, O.

Metal Washing Machine

Information about the new American Tumbl-Spray metal washing machine is now available in illustrated Circular No. 9. The new machine is designed for removing chips, dirt, grease, and oil from machined parts, stampings, screw machine parts, etc. By means of its patented endless tumbling conveyer, the Tumbl-Spray is claimed to achieve complete exposure of work to the cleaning action of the high-pressure sprays. American Foundary Equipment Company, Mishawaka, Ind.

Instrument Instruction Courses

Three new courses of instruction, planned to fill the present and future needs of the Army, Navy, Civil Service, and air-line companies for specialized aircraft instrument technicians, are announced by American School of Aircraft Instruments, Glendale, Calif.

Patterned after the Army Air Forces training program, which has been in operation at the school since February, 1942, the three new courses cover aircraft engine, flight, and navigation instruments and are grouped as follows: pressure aircraft instruments, electrical aircraft instruments, and gyroscopic

THE PERKIN-ELMER CORPORATION

Presents

ITS CREDENTIALS *to* INDUSTRY

In the field of science The Perkin-Elmer Corporation name is one of utmost familiarity. In its work for astronomical observatories and scientific laboratories, it has been able to achieve accuracy of optical systems never previously achieved.

In engineering for industry The Perkin-Elmer Corporation was one of the few concerns to apply the science of advanced optics to the problems of American manufacturing. Prior to the outbreak of the war, its files disclose a varied and surprising list of accomplishments.

To help win the war Perkin-Elmer cheerfully and wholeheartedly answered the nation's call to drop everything else and go to work for the Armed Forces. The Perkin-Elmer Corporation was one of only three companies in the field of precision optics to win the Navy E for excellence and ingenuity in production of precision optics. It was later replaced with the joint Army-Navy E award with star.

After Victory Perkin-Elmer invites industrial executives to investigate the advantages of the *optical* approach to countless problems of production and control. No other branch of applied science holds greater promise for the future.

THE PERKIN-ELMER CORPORATION
GLENBROOK, CONNECTICUT
MANUFACTURERS OF PRECISION LENSES • PRISMS and MIRRORS
OPTICAL DESIGN AND CONSULTATION

aircraft instruments including the gyro pilot.

Instruction in each of these courses is given over a period of twelve weeks, six days a week, eight hours a day—a total of 576 instruction hours. Thus the student receives the equivalent of nearly six months of inspection in his chosen course in only twelve weeks' time.

The new program embodies several innovations. One of these is the reduction in instructor-to-student ratio. Another innovation is the inauguration of demonstration and visual aids in teaching the theoretic side of aircraft instruments and their maintenance. For this purpose, the most modern types of aircraft instruments, in cutaway form, are used. These make it possible for the student to visualize, under actual demonstration, the principles of operation, repair, maintenance, overhaul, and calibration of the particular group of instruments he is studying while actually engaged in regular shop procedures that are fashioned according to commercial standards.

Dust Collector

A new portable dust collector is designed to provide an inexpensive and flexible dust-collection system for plants where dust control is needed. Its basic use is to collect dust from a grinder or other dust-making machine, separate the dust from the air, and blow the clean air back into the shop. It has a capacity of 600 cu.ft. per min. The "Safe-Aire" is powered by a 1/3-hp. motor driving an Ilg blower at 3,400 r.p.m. Its dimensions are 37 in. high, 27 in. wide, and 13 in. deep, and its weight is less than 120 lbs. Bargar Sheet Metal Company, Cleveland, O.

Drills with Plastic Housings

Using a new plastic material called "Drillite," Black & Decker has designed practical housings for the 1/4-in. standard drill and the new 3/8-in. standard drill. This plastic is made with a shredded cotton duck base to secure high impact resistance. The plastic is heat resistant and an insulator against dielectric shock.

Steel inserts have been cast into the plastic housings to carry all ball bearings and threaded steel inserts in the field housing for housing assembly screws. Steel air vents in the commutator and housing provide for motor ventilation.

The makers state that the new material permits a marked reduction in the weight of the complete unit as compared with former models using metal housings. Both units are offered with either end-handle or side-handle control, equipped with the "Pistol Grip and Trigger Switch" and with universal motors. Black & Decker Manufacturing Company, Towson, Md.

FLEETWINGS

pioneers with parts and hydraulic equipment

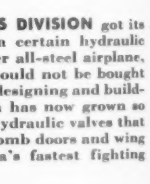
The BT-12, all-welded basic trainer built for the U. S. Army Air Forces.

ONE OF FLEETWINGS' newest time-savers is a sponge-rubber and hardwood roller to be used during taping operations. With this device the operator is able to keep his hands from continually being covered with finishing dope and to cut taping time nearly 50% over the conventional manual method.

FLEETWINGS' HYDRAULICS DIVISION got its original impetus because a certain hydraulic valve needed for the pioneer all-steel airplane, the Fleetwings "Seabird," could not be bought on the open market. From designing and building one valve, this division has now grown so large that it is producing hydraulic valves that control the landing gear, bomb doors and wing flaps on many of America's fastest fighting planes.

VICTORY GARDENING, to help relieve food shortages, is another activity at Fleetwings. Early this Spring, the company made garden tracts available to all employees who desired them. The response was tremendous. Now-a-days, after work, you'll find scores of Fleetwingers busy in their garden plots adjoining plant number two. They feel that growing what they eat is still another way to "keep 'em flying."

TO GET YOUR COPY of Fleetwings' monthly magazine, "The Arrow," merely write to us on your company stationery. In this magazine you'll find articles about production shortcuts, and other information of interest to men and women in the aircraft industry. Address your request to "The Arrow," at Fleetwings, Bristol, Pennsylvania.



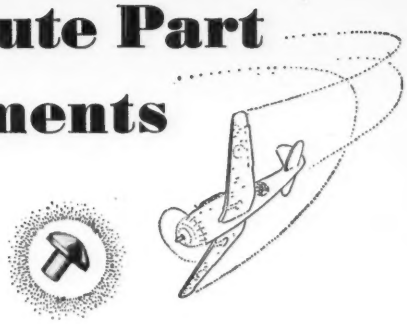
"KEEP 'EM FLYING!"

FLEETWINGS

Division of Kaiser Cargo, Inc.

BRISTOL • PENNSYLVANIA

Even the Most Minute Part Has Its Big Moments



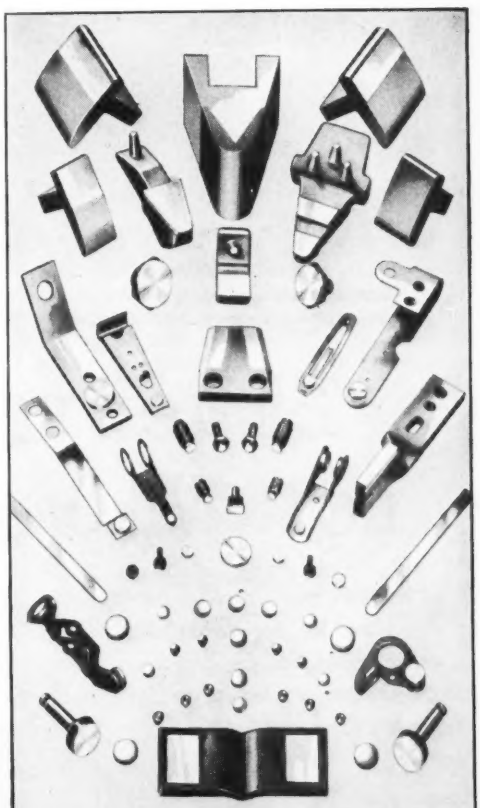
The contact points in a fighter plane's "turn and bank" indicators are not much for size, but they must be brutes for action. Like all component parts in a plane's electrical apparatus, they must function perfectly or spell trouble for the pilot. Always, he must be sure of his maneuver.

Under war need's pressure, a new type "turn and bank" indicator—an instrument in which the pointer remains stationary to show the degree of deviation from normal flight—called for contacts capable of operating 75 times a second, but extremely sensitive. Tiny contacts they are, less than a tenth of an inch in diameter, but they make and break the circuit that controls the speed of the gyroscopic motor.

Early in the designing, Mallory contact experience was sought. Standard contact materials set up excess arcing, creating unwanted radio interference. Then Mallory metallurgists, working against time, developed a combination of metals—standard tungsten for one point, Elkonium-34 for the other—that licked the problem in jig time. Just one contribution to the development of accurate combat maneuvers, to be sure, but an excellent example of how concentrated cooperation is functioning to insure that even the most minute part does its bit at the critical moment.

Mallory's years of contact experience and "know how," stimulated by war production demands, are furnishing innumerable solutions to perplexing problems of contacts and contact assemblies. Many of the applications developed in the Victory effort have significance for the future.

When you have contact problems, bring them to Mallory.



P. R. MALLORY & CO., Inc.
INDIANAPOLIS, INDIANA
Cable Address—PELMALLO

While the design is still in blueprint form

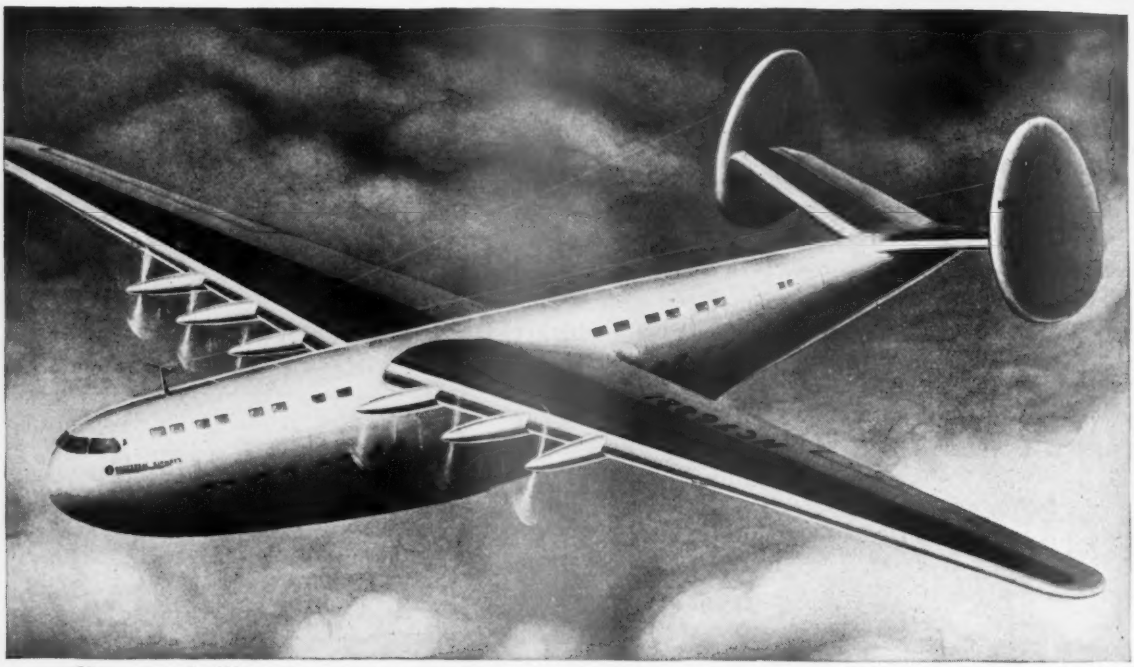
CONSULT MALLORY
for Contacts and Contact Assemblies

P.R. MALLORY & CO. Inc.

MALLORY

ELECTRICAL CONTACTS AND CONTACT ASSEMBLIES
NON FERROUS ALLOYS
POWDERED METAL ALLOYS

End-Product of Martin engineering is Army's Marauder medium bomber (shown at right), Navy's Mariner patrol bomber and PBM-3 transport, and R. A. F.'s Baltimore medium bomber.



Tomorrow's Giants have already been designed by Martin engineers. 125-ton airliners are ready to build whenever the demands of war or peace make it desirable. Martin engineers are planning even greater craft for tomorrow's Air Age.

Blueprint for Victory!

WHEN aircraft designs are released by parent companies to other companies for manufacture, what do they consist of? Are they just a sheaf of drawings . . . a portfolio of data?

Actually, the blueprints of a plane, if delivered in one bundle would fill a boxcar or several trucks.

Take the Martin B-26 Marauder: this big medium bomber couldn't carry the weight of a single set of its own blueprints, much less their bulk. By the end of 1942, the 2,000 Martin engineers had made nearly 20,000 individual drawings for this single type. Hardly a week passes without modification or change to keep our military aircraft well ahead of enemy types, and each change means new engineering, new blueprints.

Combining patient research with bold vision, Martin engineers are unfolding a blueprint for Victory . . . and for the Air Age beyond!

THE GLENN L. MARTIN COMPANY
BALTIMORE, MARYLAND, U. S. A.

Member: AIRCRAFT WAR PRODUCTION COUNCIL, EAST COAST, INC.

Martin AIRCRAFT

Builders of Dependable Aircraft Since 1909

Future Victories in the air are now being mapped on Martin drawing boards. Over 2,000 Martin engineers devote 400,000 man-hours each month toward making America *first in the air.*

Engineer's Delight is this patented new adjustable Martin drawing board, which ends back-breaking work over flat desks. Increased comfort means increased efficiency and production from Martin engineers.

The Boeing Stratotrainer

Boeing Aircraft Company recently put into operation a new low-pressure chamber that is reported to be able to simulate altitudes higher than anything previously achieved and can give the effect of climbing six times faster than a fast pursuit airplane of present design. It is claimed to be the first of its type and scope to be installed in the aircraft industry. Known as the Stratotrainer, this new low-pressure chamber will be used exclusively for physiologic research and the training of high-altitude crews by the company.

The simulated rate of climb will enable a study of the factors that contribute to aeroembolism and of the present ceiling, raising the ceiling of man above the present peak of approximately 40,000 ft. The primary purpose of the Stratotrainer, however, will be to train crews in safety precautions necessary while breathing oxygen at high altitudes. Its size permits the training of a complete flight crew at one time. The Stratotrainer ascent by a flight-test crew actually is a final examination, culminating several months of intensive training.

When the desired altitude is attained, one of the crew members simulates a faint. Another must remove the oxygen mask and fit the inert individual with an emergency mask. The process is repeated until each member of the crew has had his mask changed at high altitudes.

Interior equipment of the Boeing Stratotrainer includes the same type of headphone as is used on the Flying Fortress. Auxiliary sound equipment includes a loud speaker within the chamber to assure communication between the crew inside and those outside. The oxygen system includes both the demand type and the constant-flow type. Recording instruments with the trainer include manometer boards, poteniometers, and oximeters for practice work under actual atmospheric conditions of high altitudes. A large refrigeration unit is provided to keep the temperature inside the chamber similar to that encountered within the plane while on a high-altitude flight.

Filling Balloon Envelope

An air envelope for a dirigible, having a capacity of 123,000 cu.ft., is filled at the Goodyear Tire & Rubber Company, Akron, O., in 8 to 10 min.

This is accomplished by means of an axial-flow type blower, run by a 3-hp. electric motor at 3,600 r.p.m. The air current is carried through a duct of rubberized fabric 18 in. in diameter, which is fastened onto the outlet of the blower.

The air envelopes are inflated on the floor of the balloon division of the Goodyear company. While they are inflated, the inspectors enter to search for possible holes. The interior of the envelope is in total darkness and the bright light on the outside makes the defects visible. Compressed Air Institute.

Polishing Lathe

A polishing lathe that incorporates a clearance hole through the entire machine is now being produced by the Crozier Machine Tool Company, Hawthorne, Calif. This new feature permits polishing a portion of a piece of work of a length up to the maximum capacity of the lathe.

It is reported that work can be loaded and unloaded while the spindle is in rotation. Positive opening and closing of the collet is provided through a double-faced cam-operating mechansim that is hardened and precision ground. Adjustments are made on the polishing lathe without the use of tools—merely turning the hand grips will tighten or loosen collet tension.

A switch and mechanical brake control make the machine adaptable to work that can be loaded better when the spindle is stationary. This control lever first cuts off the power from the motor and gradually applies a molded disc-type brake facing against a cast-iron flange.

Conveyers in Propeller Production

The new propeller plant of Curtiss-Wright's Propeller Division in Indiana is claimed to be one of the most completely conveyer-equipped plants in the nation. These conveyers have practically eliminated the method of trucking production materials from one department to another or within departments.

One innovation that is expected to speed operation considerably is a slat conveyer for assembling the blades, at which the workers stand side by side assembling gears and cuffs to the blades before final assembly. All trucking has been eliminated in the hauling of cuff parts by a new belt conveyer that carries the finished parts to another conveyer station where they are placed on an overhead carrier and sent through the anodizing and dichromate processes and back to another station where they are placed on the paint conveyer.

Finished parts are delivered from the storeroom to all assembly departments on a 3,400-ft. overhead conveyer, each tray being numbered with its destination station. In the power unit and hub-assembly departments, materials are moved toward completion on roller conveyers. Monorails, with electric lifts, speed the final assembly of completed propellers and carry them through the balancing operation. After disassembly, weighing, and packing in wooden boxes, the propellers are carried on another slat conveyer and are delivered to railroad cars for shipment. Curtiss-Wright Corporation.

Development Division

A new division has been established in the Curtiss-Wright Corporation, called the Development Division. It becomes the fourth major division of the Corporation and will provide a means for implementing collaboration on engineering problems relating to the other three divisions.

The work of the new division will be primarily to expand its research and development program. Its staff will include technicians and engineers who are expert in both aeronautical and nonaeronautical fields.

Industrial Chilling Unit

Model D-70, a new Deepfreeze two-stage industrial chilling unit, provides a wide range of sub-zero temperatures. It has a maximum capacity of −70°F. and is designed to remove 800 B.t.u. per hour at that temperature. One of the uses for this new chilling unit is to provide sub-zero cold for the testing of aircraft instruments and parts and plastics, rubber, and a wide variety of materials used in war production. In the aircraft industry it is employed for retarding the aging of aluminum rivets, for storing annealed aluminum-alloy metals, for shrink-fit assembly of parts, and for many other applications.

The chilling chamber consists of a double-wall cold cylinder that entirely surrounds the walls of the chilling compartment. Interior diameter of the cylinder is 18 in. and the depth is 30 in. The unit's overall height is 37 in.; length, 67 in.; width, 36 in. It gives over 24 sq.ft. of primary freezing surface and a capacity of 33 gal. Power is supplied by a $^3/_4$-hp., 110–220-volt motor equipped with built-in thermal overload.

Other features of the D-70 include two compressors with refrigerated heads, a temperature control that is adjustable from atmospheric temperature to −70° F., a special expansion valve that is electrically controlled, and a dehydrator charged with silica gel. It employs two-stage compression and single-stage refrigeration principle.

Members of the Deepfreeze line include the Deepfreeze Cascade, which provides temperatures as low as −120°F. for stabilizing metal gauges, cold-treating metals, etc.; the Deepfreeze Santocel for working temperatures as low as −50°F.; and other models that

are built to order to meet special requirements. Deepfreeze Division of Motor Products Corporation, North Chicago, Ill.

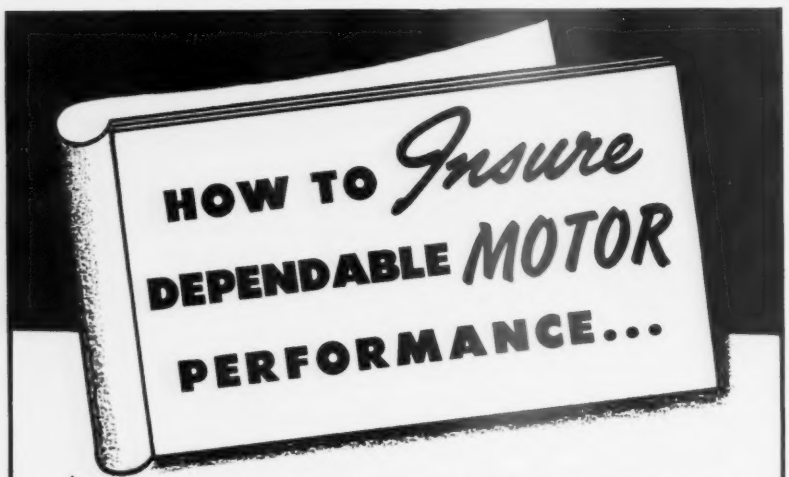
Plastic Insulation for Electroplating

It is stated that landing gear struts for airplanes are chromium plated rapidly by using a tube of "Lucite" methyl methacrylate resin to protect the treated end during plating.

The crystal-clear plastic that is also used for transparent sections of military aircraft has been found to be extremely durable as a protecting or insulating material in chromium electroplating baths.

One aircraft manufacturer is reported to be using a $5^1/_2$-in. diameter tube of the plastic to protect the struts. Electroplaters who have used "Lucite" to insulate the positive and negative anodes in their chromic acid baths report that it stands up indefinitely in the acid and retains its shape.

Plastic insulators are used also in the electrodeposition of chromium on steel, brass, and bronze parts for military equipment. E. I. du Pont de Nemours and Company, Inc.



★ To insure the type of motor performance so essential for the successful operation of today's equipment, design engineers are placing increased emphasis on these important requirements:

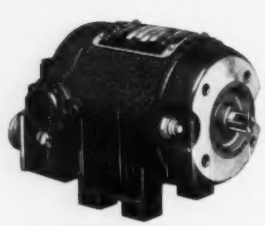
1. Thorough Engineering . . . to secure a motor designed to meet the requirements of a particular application.

2. High Efficiency . . . to insure the required power with minimum size and weight.

3. Exacting Manufacture . . . to produce a motor which will fulfill these important requirements.

These factors are recognized standards in the design and manufacture of Black & Decker motors.

THE BLACK & DECKER ELECTRIC CO., Kent, Ohio



THOROUGH ENGINEERING is the basic factor behind the successful operation of this de-icer pump motor and many other special application motors we have designed for all types of equipment.

Black & Decker
FRACTIONAL HORSEPOWER SPECIAL APPLICATION MOTORS

Pneumatic Mixers

Pneumix agitators are operated by air motors. It is claimed that these agitators eliminate fire and explosion hazards. Speed is regulated by air throttle control so that any rate up to 6,000 r.p.m. can be obtained and maintained with the direct-drive agitators and lower maximum speeds can be reached with the geared models. Increasing pressure maintains the speed if the material thickens in mixing; decreasing pressure keeps the speed constant if material thins.

The air motor is totally enclosed and splashproof. No moving parts come in contact with the material being mixed. Exhaust mufflers are provided to secure quiet operation.

These agitators are used as portable equipment and as permanent installations, and remote control is available for use on noxious mixes. They are being employed on such materials as pyroxylin lacquers, varnishes, petroleum products, high explosives, ethylations, synthetic resins, synthetic rubbers, fine chemicals, and other liquids. Eclipse Air Brush Company, Inc., Newark, N.J.

Two Gliders for Sea Observation

A means of combating the submarine by tow gliders with folding wings, attached by cable to war vessels and merchant ships, has been suggested by Col. Edward S. Evans, industrialist, who is credited with having predicted the advent of "flying boxcars" and the glider train.

It is stated that properly designed gliders can be developed as observation craft for the Navy and merchant marine. Attached to slow vessels moving at 15 to 20 knots or less, these trailer planes can rise to a height of 1,000 to 2,000 ft. for observation. Faster ships such as destroyers and cruisers will permit the glider to gain an altitude of 2,000 to 3,000 ft. Submarines or approaching enemy ships and convoys can be spotted by the Navy in time to take action. The gliders are claimed to be valuable in offense, as well as defense, when carried by destroyers or merchant ships. They can be designed to conserve space and can either be carried aboard ship with their wings folded to fit into a V-shaped cradle or can hang over the stern of the ship if necessary.

As the vessel moves forward, the glider with its pilot is released from its cradle by a winch and begins ascent, the cable gradually being played out until the desired altitude is reached. To bring the glider back to the ship, the winch is started and the glider is pulled in. The radius of activity of the glider is circumscribed only by the speed of the ship and the length of the cable. Evans Products Company, Detroit, Mich.

PERFORMANCE CONTROLS THE AIR

Consolidated Liberator

The Berlin radio was silent last night. This morning we know why. *The Yanks again!* What a performance record these big war birds are setting for going places, doing things, and coming home. It's precision exemplified. That's the inspiration of every worker here at home, to make every plane part a model of precision.

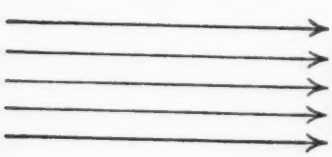
PESCO Fuel Transfer Pump widely used on American aircraft

In Aircraft Hydraulics, Fuel Pumps, Air Pumps, Related Accessories...

PERFORMANCE POINTS TO Pesco FIRST

DIVISION BORG-WARNER, CLEVELAND, OHIO

The alloy steel
with unusually high
resistance
to
Shock
and
Impact



N-A-X
High Tensile

Resistance to impact and fatigue—those are the properties of N-A-X HIGH TENSILE that keep mobile equipment on the job in all kinds of weather—rain or shine—sleet or snow—in blazing hot or sub-zero temperatures, year in and year out.

Builders of mobile equipment like N-A-X HIGH TENSILE for usually there are no shop "change-overs" required for its fabrication. It can be cold formed easily and welded by any of the standard practices used for mild carbon steel.

There are other valuable properties of N-A-X HIGH TENSILE, too, that aid materially in extending the service of mobile equipment. They are: unusual ductility, high yield point and ultimate strength, excellent resistance to corrosion and abrasion, extremely high resistance to fatigue and impact, at normal as well as at sub-zero temperatures.

Would you like to know more about N-A-X HIGH TENSILE? A Great Lakes engineer, who has wide experience in the use of this remarkable low alloy steel in hundreds of applications, is available at any time to talk over your requirements or give you advice on its use. Write, telephone or wire for one today.

GREAT LAKES STEEL CORPORATION, DETROIT, MICH. *Sales Offices in Principal Cities*

Division of NATIONAL STEEL CORPORATION Executive Offices, Pittsburgh, Pa.

Extruded Plastic Tubing

Tulox TT seamless plastic tubing is now available in all diameters up to 2 in. outside diameter and the range will soon be increased to $2^1/_2$ in. outside diameter. This tubing is extruded from Tennessee Eastman cellulose acetate butyrate and is available from warehouse stocks throughout the country. Extruded Plastics, Inc., Norwalk, Conn.

Revised Primary Trainer

A revision of the Fairchild PT-192A is now in production at a plant of Fairchild Aircraft. The revised model incorporates navigation lights, instrument lights, a 24-volt battery, an engine-driven generator, and an electrical interphone system. This model is painted aluminum with the top portions of the cockpit and engine cowlings black to reduce glare. The gross weight is just over 2,500 lbs. Top speed is 125 m.p.h., with a cruising speed of 106 m.p.h. The plane is 27 ft. 8 in. long and has a span of 36 ft.

Aeronca Aircraft Corporation, which is now building the PT-23 for the Army Air Forces, is expected to go into production soon on the new Fairchild trainer. Howard Aircraft, St. Louis Aircraft, and Fleet Aircraft, Ltd., are also now building the Fairchild PT-23, which is powered by a Continental 220-hp. radial engine. The new Fairchild is powered by a six-cylinder, inline, Ranger air-cooled engine of 175 hp. Fairchild Engine & Airplane Corporation.

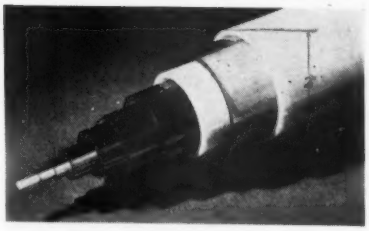
Anti-Icing Propeller Covers

Recent development has perfected more efficient means of distributing the anti-icing fluid farther out on the propeller blade and has provided better and quicker methods of application of the fluid.

Recently perfected manufacturing processes involving grooves in the cover permit molding the cover with sides at right angles instead of flat. Such a molded cover, when installed over the curved edge of the blade, causes the sides of the center groove to close in or converge at the surface. This provides a pocket for the anti-icing fluid to flow outwardly and distribute over a greater length of the blade. A special heating method insures uniform and rapid installation. The synthetic rubber is claimed to offer effective resistance to abrasion and to adhere to the aluminum blade with an ample factor of safety irrespective of temperatures and oil leakages encountered. Firestone Aircraft Company, Akron, O.

Cable and Tube Pressure-Sealing Bushings

Researches to make high-altitude flying more feasible have developed a



"Tulox" TT seamless plastic tubing extruded from Tennessee Eastman cellulose acetate butyrate.

design of synthetic rubber bushing which may be conveniently used to render airtight the entry of cables and pipes through the side wall of the pressurized cabin of the high-altitude plane.

Around the outer diameter, a specially developed groove seals airtight when the bushing is snapped into place. Around the inner diameter, a series of lips come tightly in contact and seal and support the entering cable or tube. No tools are required for insertion and the "shock absorber" effect of the rubber eliminates appreciable vibration. Electrical conductive rubber may be supplied so that additional radio interference ground clamps are not required.

A recently developed guide bushing consists of a synthetic rubber ring with an annular groove around its maximum diameter, designed to assure a satisfactory fit in panels varying from 0.030 to 0.090 in. in thickness. Other designs for use in thicker panels can be supplied on special order. The opening through the center is convex in section and lined with a specially lubricated Firestone low-friction material. This lining is cured to the synthetic rubber and gives the grommet its properties of resistance to wear and abrasion. The lubricated fabric lining affords protection for tubing or flexible control cables. Firestone Aviation Products Company, Akron, O.

Refrigerated Welding Electrodes

A 6-page, 4-color Bulletin P-43 has been released by Frostrode Products, Detroit, Mich. It describes the design, construction, and operation of the "Frostpoint" permanent electrodes with replaceable finned "Frostcaps," as well as the "Frostpoint" adapter holders to convert any spot welder to the process. Colored illustrations show coolant circulation, improved installation practice, and the method of cap replacement with electric pliers.

Magnetic Reversing Switch

The Furnas magnetic reversing switch permits reversing control of motors by the use of push buttons close to, or remote from, the installation. Its features include silver contacts, mechanical interlocking, low-voltage protection and release. Vertical or horizontal mounting can be provided and a special weatherproof type is available. Bulletin 4216 describes these switches. Furnas Electric Company, Batavia, Ill.

Magnetic Reversing Switch

The improved 5-hp. Furnas magnetic-reversing switch is made as a single unit instead of being made up of two separate contactors. The maker states that this design allows for reducing the switch to a compact size and eliminates internal wiring. It is especially suited for severe plugging service and other heavy duty. Features include large, double-break silver contacts and the absence of pivots or bearings. Furnas Electric Company, Batavia, Ill.

Radionic Frequency Meter

Four new models of the Telrad Frequency Meters are announced. All models are crystal-controlled and have harmonic amplifier circuits providing a range of frequency carrier signals from 100 cycles to 45 megacycles. A carrier signal is also produced every 1,000 kilocycles from 1 to 120 megacycles. It is reported that in the operation of these meters no calibration or tuning charts are necessary. The carrier output is fed into a receiver and the carrier frequency may they be adjusted to zero beat with any receivable primary standard or reference frequency. Special models designed for use under adverse conditions are available, equipped with two precision crystals that have been ground to produce exact frequencies of 100 and 1,000 kilocycles and tested for operation at temperatures from −35° to +55°C. and have temperature coefficients of maximum drift of only 2 and 3 cycles per megacycle per degree Centigrade, respectively. Fred E. Garner Company, Chicago, Ill.

Shipping Aircraft

Aircraft parts for United Nations' air forces are now being shipped in wirebound boxes or crates designed for the purpose.

In preparing airplane wings for shipment, they are first individually wrapped in heavy Kraft paper, cushioned with excelsior, and then placed side by side on their edges. Despite the length of the crate, intermediate cleats are not used because they would cause too much weight concentration that might result in possible denting of the wings. Lengthwise rigidity is provided by a 1 by 4 collar that is attached to the outside of the crate and centered, end to end. Frames are then placed one-third the distance from each end of the crate. Other general wirebound crates are designed to meet

specific shipping problems. General Box Company, Chicago, Ill.

Atomic-Hydrogen Arc Welding

High-temperature atomic-hydrogen arc welding is being used in the fabrication of high-altitude airplane equipment. Among the principal items made with the aid of this process are oxygen containers, hollow propeller blades, and superchargers. Oxygen containers can be made of thin steel sheets, provided the seams joining them are strong enough to resist the pressure of the oxygen. It is stated that atomic-hydrogen arc welding is a satisfactory process for joining the seams.

Fabricating hollow propeller blades presents a similar problem, calling for strong joints in thin metal. Atomic-hydrogen arc welding has also been utilized to advantage in the joining of light-gauge sections of stainless steel in the production of superchargers.

Atomic-hydrogen arc welding differs from the ordinary arc-welding process in that the arc is maintained between two electrodes rather than between one electrode and the work. Because the location of the arc can be controlled and because the arc has no tendency to blow the molten metal out of the joint, it is claimed that precise control of metal fusion is afforded. The process employs a stream of hydrogen gas in which a change of molecular state enables the arc to heat the work to be welded at a high rate of speed. Hydrogen excludes oxygen and other gases that would combine with molten metal to form oxides and other impurities. General Electric Company.

Portable Furnace and Ladle Improves Aluminum-Casting Technique

More than 2,500 castings for a piece of Army equipment have been made with a 1,000-lb. capacity portable melting furnace and ladle combination at General Electric's Schenectady works with a negligible percentage of rejects. The portable furnace obviates the need for superheating its charge to the point where oxidation would be excessive and, by permitting a direct pour from furnace to mold, does away with the problems of preheating transfer ladles and crucibles.

The portable combination is a conversion of a standard oil-fired furnace and ladle. It is trunnion-mounted, with two-eyed plates welded on both of the frame uprights for lifting the entire assembly by a four-hook crane sling.

The furnace is fired by a removable burner easily attached to the sidewall by sliding it into a semicircular flange and locking it down with a wing nut. The burner fixture fits against the furnace wall at a tangent so that the flame is spiraled downward into the charge. Oil is fed through a flexible metal hose and air through a rubber hose.

Because the casting for which the furnace is used is about $\frac{1}{2}$ in. thick, the best pouring temperature is from 700° to 710°C. Ordinarily it would be necessary to heat the aluminum charge to as much as 800°C., but with the portable furnace-ladle combination it is only necessary to heat to 750°C.

About one-third of the more than 2,500 castings made with the portable furnace were of an aluminum alloy of about 5 per cent silicon and the balance aluminum, corresponding to Navy Specification 46A1, Class 2. Among those there were no rejects. It is reported that the slight difficulty encountered was not the fault of the furnace but was due to inexperience in handling another metal when a shift was made to an aluminum-copper-silicon alloy (4 per cent copper, $2\frac{1}{2}$ per cent silicon, balance aluminum) corresponding to Army-Navy Aeronautical Specification AN-A-4. No "cold shots" were experienced on any of the castings, indicating proper temperature.

The portable furnace and ladle combination, loaded with its charge, weighs about 3 tons.

Welding Equipment Converted for Incandescent Brazing

Among the special-purpose machines converted from peace to war production are some spot-welders and line-welding machines previously used for refrigerator unit manufacture and now used for incandescent brazing.

The spot welders were adapted for incandescent brazing by the following three changes: (1) A switch was installed in the controller box to provide the continuous flow of power necessary without the use of the drive motor. (2) The standard spot-welding electrodes were replaced by dummy copper electrodes drilled and tapped at one end where copper blocks are attached for the water-cooling supply and return. (3) To these copper blocks were attached large water-cooled leads (183,000 circular mils) and brazing tongs.

The leads were made 10 ft. in length so that the working area would not be limited to the table. Plier-type brazing tongs can be connected to these leads and brazing operations performed within a 10 ft. radius of the table. This permits other jobs to be set up while working on one.

The transformers were removed from the line-welding machines for installation elsewhere as needed. These spot- and line-welding transformers have a range of from 75 to 250 kva. in capacity, operating on 550 volts a.c. primary and 4 to 14 volts secondary, having a range

DYNAMOTORS
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The men in the planes can tell you that it takes perfect coordination of every factor—of manpower, plane and instruments—to come out on top in a dog-fight. Dynamotors don't do the shooting—but they furnish the necessary power for radio communications, direction-finding, radio compass and other instrument controls which enable our men to find the enemy, attack and come back safely. Eicor Engineers are proud of the job Eicor Dynamotors are doing today in fighters, bombers, trainers and transports.
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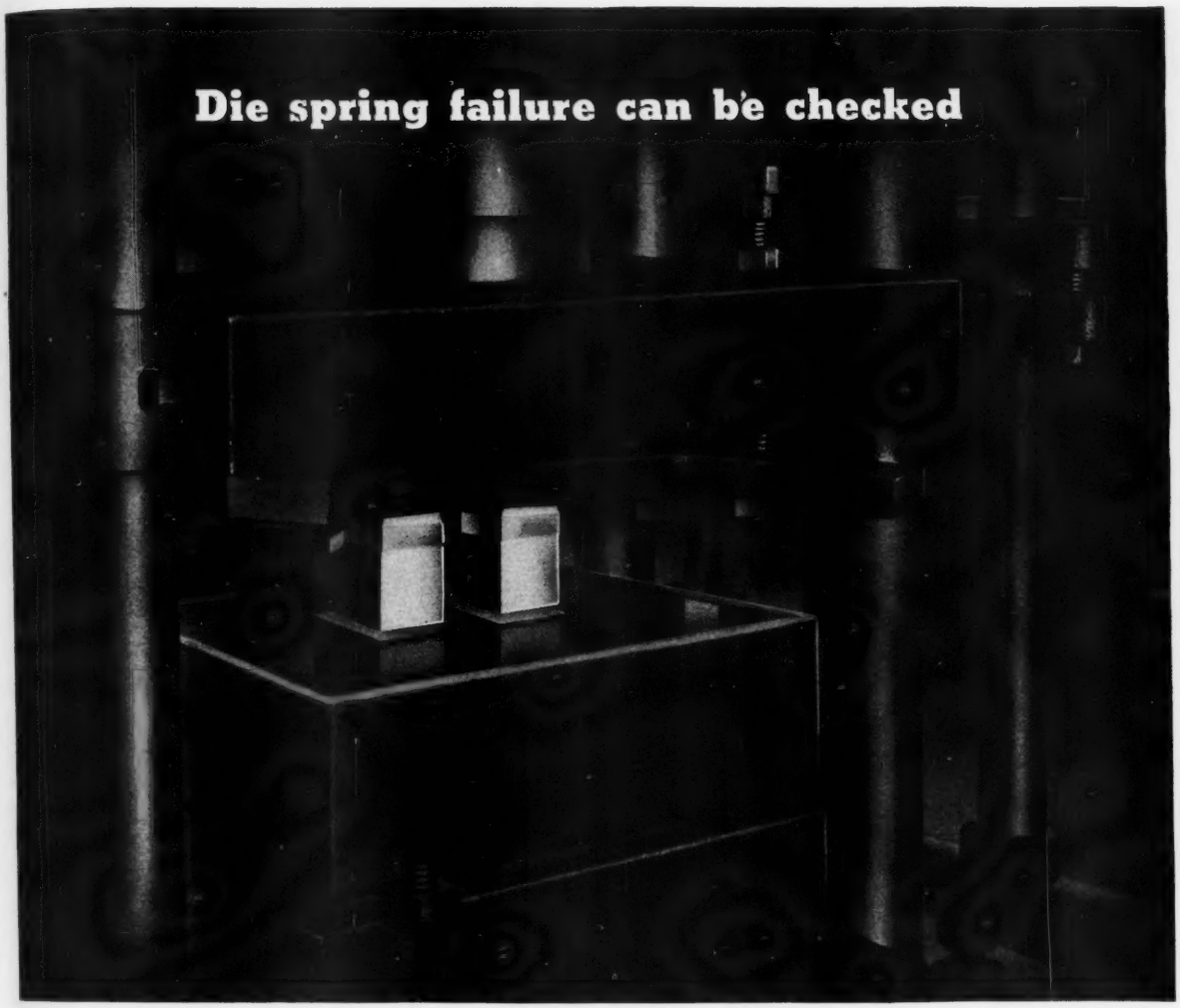
Die spring failure can be checked



Information supplied by an Industrial Publication

A recent investigation of die spring breakage developed the following prominent causes:

1. Hydrogen embrittlement resulting from plating, pickling or cleaning.
2. Incorrect die design.
3. Incorrect spring size.
4. Speed of compression cycle.
5. Poor quality of wire.

There are, fortunately, remedies for all these conditions. Hydrogen embrittlement can be corrected by heating plated springs to about 450°F. and air cooling.

Faults in die design usually consist of either insufficient or too great clearance between the outside diameter of the spring and the guide hole. The clearance should be such that the spring operates freely, but has no chance to buckle.

Care should be taken in selecting springs to see that they are properly designed for both length of compression stroke and speed of compression. If springs are repeatedly compressed too close to their solid height, quick failure will result. The same is true where the rapidity of compression is too great.

It seems obvious that the quality of the spring wire should be commensurate with the job. Cheap wire should be avoided because of defects that are bound to cause trouble, especially when springs are plated.

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.
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MOLY

Corsair CLIMB

Flashing up to meet the enemy, the Corsair pilot climbs with the dominating power of two thousand horses. Quickly on top, he strikes with a wealth of armor and armament.

For twenty years Vought war planes have flown with the Navy. This F4U-1 is the twelfth to bear the proud name Corsair.

CHANCE VOUGHT AIRCRAFT

STRATFORD, CONNECTICUT

ONE OF THE FOUR DIVISIONS OF UNITED AIRCRAFT CORPORATION

of from 0 to 16 points of heat. This extra range in secondary voltage permitted the use of longer leads than would be possible with the 10- and 20-kva. brazing transformers ordinarily used, and were ideal for that reason. They are water-cooled, minimizing the possibility of burnouts from overloading. General Electric Company.

Chemigum Coolant Hose

Especially compounded Chemigum is now being used in place of natural rubber for hose connections in at least one major type of airplane engine.

Developed since the United States entry into the war, the synthetic rubber hose connections are described as superior to natural rubber in resisting leaks and seepages of the special antifreeze fluids used in planes that fly in high altitudes.

It is stated that synthetic rubber in this application also provides greater resistance to distortion and to deterioration from oils and greases. Goodyear Tire & Rubber Company.

Shutter-Type Pilot Light

The Gothard Model 430 and 431 shutter-type pilot light is offered for aircraft, marine, signal, and similar applications where various intensities of light are desired under constantly changing conditions. These new pilot lights permit a gradation of light from bright, through intermediate glows, to total dark with 90° rotation of the shutters. These lights are available with red, green, amber, blue, or opal lens and also with polarized lens. Gothard Manufacturing Company, Springfield, Mass.

Lightweight Aircraft Solenoid Contactor

The new type B-8 solenoid contactor is designed to meet U.S. Army specifications for remote control of aircraft-engine starter motors. It performs a function similar to that of the type B-4 contactor with which it is interchangeable on intermittent duty applications. The contacts on the B-8 solenoid contactor close firmly at 6 volts, whereas on the B-4 type 18 volts are required to close the contacts. In addition, the B-8 solenoid contactor complete with terminal bolts, nuts, and washers weighs approximately three-quarters of a pound less than the B-4 unit.

The B-8 is a single-pole contactor with double-break, normally open contacts and is described as being so constructed that the contacts do not chatter as a result of voltage drops caused by starting motor current surges. Contacts are rated at 200 amp. The B-8 type operates at 24 volts d.c., intermittent duty. At 24 volts the coil draws 3 amp. Similar contactors, built for continuous duty, are types SC-25 and SC-45. Guardian Electric Manufacturing Company, Chicago, Ill.

Case Hardening

Holden Hy-Speed Case is offered for three principal purposes: (1) to give increased hardness on the surface of high-speed tools; (2) to provide additional hardening for an existing tool; and (3) to overcome a slightly decarburized surface.

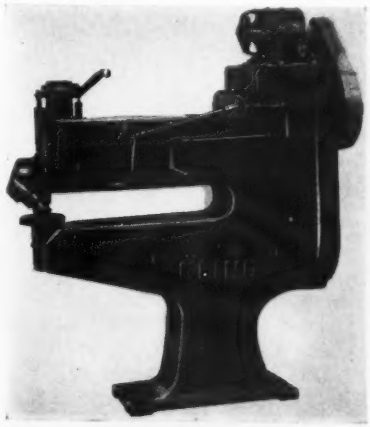
The material is a liquid bath with an operating range of 950° to 1,110°F., used to impart an increased surface hardness to high-speed tools previously hardened, tempered, and ground to size. It melts at approximately 850°F. and is claimed to be completely water-soluble. The makers state that it is a stable compound and, with minor additions of approximately 5 per cent of the weight of the bath per week, the melting point remains unchanged. The A. F. Holden Company, New Haven, Conn.

Circuit Breaker Plug

The new Hopax circuit breaker plug is intended to replace the conventional receptacle plug, provide protection against dangerous overload, danger from stalling due to low voltage and locked motors, and for fractional horsepower motors, power tools, devices using heating elements, etc. It also is designed to protect fluorescent lighting units in case of a short circuit or ground.

Individual protection is provided for each piece of equipment on a circuit where multiple equipment is operated on the same circuit, so that faulty operation of one piece of equipment does not affect the other units operating on the line. The faulty unit can be removed, repaired, and replaced without hampering production. The Hopax plug automatically disconnects the faulty piece of equipment from its electric supply.

A small red lever breaks the connection. The plug does not have to be renewed after the circuit has been broken. It is reset by simply raising and lowering the lever. The plug is actuated by heat, thus providing a time delay feature that prevents needless interruptions. Hopax Industries, Inc., Chicago, Ill.



A Kling Bros. (Chicago) all-purpose rotary shear.

Portable Battery Charging Generator

A portable, gasoline-driven generator is designed to charge 6-, 12-, or 24-volt batteries at 10 to 300 amp. It consists of a specially designed generator driven by a 6-hp., single-cylinder, air-cooled gasoline engine, which is equipped with air cleaner, gasoline filter, magneto, self-starter, rope starter, gas tank, and remote stop control. The entire unit is mounted on a skid-type base equipped with wheels.

The manufacturer states that, in addition to its use for battery charging and engine starting at airplane factories and airports, the equipment can be used as a direct-current lighting plant with an output range of 1,000 to 3,000 watts. Hunter-Hartman Corporation, St. Louis Mo.

Nonferrous Metal

"Indium" is offered as an alloying element for the nonferrous metals in such applications as imparting wear resistance and corrosion resistance to bearing metals, for protecting surfaces against tarnishing, for lengthening life of contact metal in the electrical field, for improving the spreading and bonding qualities of lead-silver solders, and for numerous other applications. The Indium Corporation of America, Utica, N.Y.

Rotary Shears

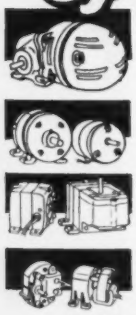
The Kling line of rotary shears has been developed to meet the need of high-speed precision shearing of sheet and plate. Kling rotary shears are designed to perform a wide range of functions with the aid of various attachments. One unit cuts straight lines, openings, circles, odd shapes, strips, flanges, bevels, joggles, and offsets. With this unit, it is claimed possible to shear any shape desired, including parts with small radiuses, right- or left-hand. Attachments are available for all the functions named. These shears can also be equipped with rolls for beading, U-ing, wiring, and forming operations. They are designed to cut plate up to 1 in. thickness in mild steel and of proportionate thickness in other metals.

Cutters are made of oil-hardened, heat-treated, tool steel. A gib key provides for any take-up resulting from natural wear on the cutter heads. Rapid setting of the cutters in the proper shearing relation is provided by an adjustment on the lower cutter shaft. Kling rotary shears are made in six models, with maximum shearing capacities ranging from 1/8 to 1-in. plate. Kling Bros. Engineering Works, Chicago, Ill.

Small Electric Motors

FOR ANY APPLICATION

SpeedWay



For more than 35 years SpeedWay has designed and built small plain and back geared motors to satisfy the thousand varied needs of industry. Today SpeedWay's long experience, mass production methods, and engineering genius are serving the interests of mechanized war promptly and effectively.

• If you need small motors • from 1/3000 to 1/3 h.p. • wound for A.C., D.C., or Universal operation • plain or back geared • in quantities of from one to a million • call on SpeedWay.

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ENGINE COOLING RADIATORS

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Universal-Type Tool Post Grinder

A small heavy-duty grinder is announced for internal, external, face, and taper grinding on lathe, shaper, planer, miller, or bench. Its special method of quill adjustment provides the equivalent of two different length quills, because the motor may be shifted 2 in. on a slide bracket. The grinding quill is likewise adjustable 2 in.

The quill assembly is balanced statically and dynamically. The quill is mounted in four preloaded matched sets of ball bearings that are lubricated by a fog oil bath. A two-step V pulley provides spindle speeds of 6,000 to 13,000 r.p.m. Power is supplied by a $\frac{5}{8}$-hp. heavy-duty, high-speed, ball-bearing, two-pole, series-wound universal electric motor, with built-in blower, for operation on direct current or alternating current of 25, 50, or 60 cycles, single-phase. Wheel guard, diamond dresser, abrasive wheels, and spindle extension are included in standard equipment. Lempco Products, Inc., Bedford, O.

Fighter Pilot Practice

In order to provide postgraduate combat pilot trainees with actual flight training in the Army's current single-seater fighter aircraft, a way has been found to accommodate a passenger in the pilot's cockpit. Several Lockheed Lightning fighters have been modified to permit an Army Air Forces trainee to sit close behind the pilot's seat and get the benefit of instruction by a seasoned test pilot.

This special "piggyback" arrangement is made by removing enough of the radio equipment behind the pilot's seat to allow another man to sit on the main center beam of the airplane. He is enclosed in the pilot's cockpit, his head close to the pilot's shoulder where he may see all instruments and controls as the pilot operates the plane. It is stated that by riding in this small capsule cockpit with an experienced pilot, a cadet can learn more in a flight of one hour than he could in months of solo experimentation. In this way the trainee receives actual experience in difficult aerobatics and other advanced flying technique, such as how to fly a twin-engined craft of this type on a single engine, use of the flaps, and rolling, looping, diving and other maneuvers. Lockheed Aircraft Corporation.

Streamlined Droppable Gasoline Tanks

Streamlined, laminar-flow droppable tanks for installation in Lockheed Lightning fighters, Vega Ventura bombers, and other American aircraft are in production with the aid of a continuously moving conveyer line and the use

GRAND QUIKCET

SETTING THE PACE ON EVERY PRODUCTION FRONT

Saving 90% of clamping time—new designs for high speed production work, one hand operation. **Non-creep replaceable grips, proof-tested alloy steel construction of forged clamp capacity.**

Quikcet 4 second clamp will hold tight even on tapered surfaces without creeping. Fast ratchet rod action under powerful fulcrum leverage. Screws, rods and handles copper plated against welding spatter.

A complete line of modern time-saving clamps — both malleable iron and alloy steel: Dual Grip "C" Clamps; Heavy Duty Speed Clamps, Standard DeLux; Standard Alloy-Steel; and Quick Lockcet, the last word in modern clamp design. *Write today for circular.*

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SPRING TESTER

Using a torque wrench (any standard make) as its measuring element the **STURTEVANT Spring Tester** will accurately measure the recoil pressure of a spring compressed to any predetermined length . . . tests compression springs up to 2½" OD and 7" length.

No Elaborate Setting Up—test platform adjusted for test length of spring by merely revolving on threaded vernier scale. Can be adjusted in a few seconds to within .003".

Anyone Can Operate—operator places spring on platform, pulls down on wrench handle until **tone device sounds** taking reading at that point from scale on wrench. Only one scale to watch.

Low Cost—makes STURTEVANT Testers practical not only for test laboratories but for general inspection use thruout plant, and for accurately matching springs, as sets of valve springs, etc.

Immediate Delivery. Write for Circular.

P.A. STURTEVANT CO.
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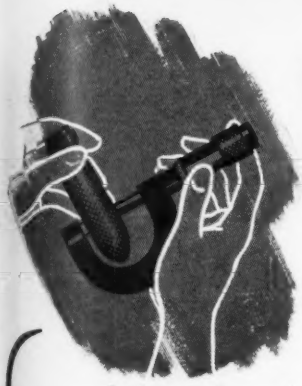

FUEL LINE STRAINERS *built with* BOMB-SIGHT PRECISION...

...Exceptionally close tolerances and deep drawing accomplished through use of Monel wire cloth

Proof of the *excellent fabricating qualities* of Monel wire cloth are these strainers for use in military aircraft. Consider the strict requirements of this application:

The wire cloth employed must resist abrasion, corrosion, wear and abuse. In addition, the strainers must be fabricated to tolerances as exacting as plus .0 inch, minus .001 inch. One of the strainers, for fuel tank inlet, is produced by a five inch deep draw!

Such results are obtained with Monel owing to its unique combination of high physical properties, fabricability and weldability. Its high strength, stiffness and ductility assure uniformly woven cloth, and proper forming. Its weldability permits simplicity of design and speed in fabrication. Together these factors permit the Michigan Wire Cloth Co. to turn out the precision made strainers required by aircraft.

THE INTERNATIONAL NICKEL COMPANY, INC. • 67 WALL STREET, NEW YORK, N. Y.

MONEL ("Monel" is a registered trade-mark of The International Nickel Company, Inc., which is applied to a nickel alloy containing approximately two-thirds nickel and one-third copper.)

1. Fuel Tank Inlet Strainer made from 5 mesh, .023" diameter wire Monel wire cloth, with brass reinforcements.

2. Fuel Line Strainer made from 60x50 mesh, .008" diameter Monel wire cloth, with brass ring and flange and phosphor bronze reinforcement strips.

3. Fuel Line Strainer made from 60x50 mesh, .008" diameter wire Monel wire cloth, with brass flange and collar reinforcement.

4. to 7. Finger Strainers for Gas Tank Outlet. Made from 18 mesh, .018" diameter wire Monel wire cloth, with brass ferrules and collars.

but it took more than courage and skill to conquer the air

Wings... rudder... a power plant and man's courage launched the conquest of the air. Years of research and development have brought the flying machine to its present high state of perfection. But, it took more than a flying machine to conquer the air. Electronic Vacuum tubes and radio communications have, perhaps, contributed more than any other single thing to this great achievement.

Eimac tubes and Aviation have been close companions for years. The inherent stamina, high performance and dependability of the Eimac 250T (illustrated) helped make air travel safe by fulfilling its important role in the key sockets of aircraft ground stations and instrument landing devices throughout the nation. Today the marriage of Eimac tubes and the Aviation industry has been made complete by the cooperative advancement of both industries concentrating on winning this war.

Eimac and Aviation are together today to help win the war. They will stay together tomorrow to bring greater advancement in peace.

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TUBES

Army-Navy "E" flag awarded for high achievement in the production of war material.

of ingenious spot-, roll-, and seam-welding equipment.

Each tank, weighing 90 lbs. when empty, weighs 1,000 lbs. when filled with 165 gal. of gasoline. Two such tanks, when clamped with releasable brackets beneath the wings, will approximately double the normal range of a Lockheed Lightning. The aerodynamics problems have been so skillfully overcome that the two tanks, when full, reduce the speed of the airplane only 4 per cent.

To meet the Army's call for a droppable tank that would cost little, use no critical material, and be adaptable to a high rate of production, Lockheed engineers, after extensive wind-tunnel and static vibration tests, decided upon a tank made in two half shells, of 1,010 body steel, 0.024 in. thick.

This was made possible largely through the use of spot-, roll-, and seam-welding equipment conceived by the Plant Engineering Department and designed in collaboration with the Plant Engineering equipment design group. It is believed that two of these special welders are the first of their type constructed in this country. The first of these machines is a portable seam welder; the second, a roll-spot-welding fixture.

The manufacturing layout consists of an overhead conveyer from which the cradles are suspended, each cradle holding one tank, and the complete assembly conveyer holding 36 cradles. The welding and assembly equipment are located at various stations along the conveyer line in the sequence in which the operations are performed. The tank leaves the first conveyer line to enter a slushing booth where the inside is completely coated with a special zinc chrome primer as protection against corrosion; then it is placed on the second conveyer which carries it through the various processing stations and, finally, to the platform beside the freight cars where it is placed in a prefabricated crate for shipping. Lockheed Aircraft Corporation.

Pressure Units and C-Clamps

Bulletin 43 describes Twistite push-pull pressure units, C-clamps, and holding devices of special design into which Twistite units can be built. Twistite pressure units employ a push-pull design that sets the pressure bar in any position from full open to full closed. An eccentric spline arrangement enables the operator to lock or unlock the pressure bar with a single twist.

The unit consists of a smooth, unthreaded pressure bar and a threaded pressure collar enclosing a roller locking pin in an eccentric spline. The bar is centerless ground and, when released, slides freely to any required position. The bar is manipulated by a knob or handle.

In assembly work the threaded pressure collar is fastened to a jig or fixture. In its unlocked position the bar is free to slide axially into position against the part to be held. A twist to the right locks the bar integral with the collar. Thereafter, continued tightening develops the required pressure as the threaded collar takes up the load. To unlock, the operation is reversed.

A similar principle has been applied to C-clamps, eliminating the threaded bar. In its place is the pressure unit described, which is instantly adjustable, locking and releasing the work with a quick turn of the handle. Michigan Clamp Company, Jackson, Mich.

Plastic Tubing and Fittings

The makers of Mills-Plastic tubing and fittings have produced a new 6-page circular containing information on this plastic material. It tells of the use of the plastic tubing and fittings, first as a replacement, then later as a product with such qualities as to compete with metal tubings and fittings in new uses.

These plastics are of SAE type and sizes of $^1/_8$ to $^3/_4$ in. They are especially designed for high working pressure and to be chemically resistant. The circular lists many uses of this flexible product and gives detailed data and physical properties of Mills-Plastic, showing charts and tables of working pressures. It also illustrates how to flare the tubing and how to form it and make bends without kinking. Elmer E. Mills Corporation, Chicago, Ill.

Mustang Dive Bomber

It has been announced that the P-51 Mustang fighter plane has been produced as a dive bomber, this new version of the Mustang being designated the A-36.

The lines of the Mustang fighter were retained in the dive bomber, making the design suitable for three military tasks—a fighter, a ground attack plane, and a bomber. It is reported that the airplane is equipped with dive brakes, bomb racks, and six high-caliber machine guns; it is powered by a twelve-cylinder Allison engine, giving flying speed stated to be in excess of 400 m.p.h.

The engineers indicate that less than 200 lbs. were added to the normal gross weight of the fighter through the addition of dive-bombing equipment. The A-36 is credited with ability to climb at the rate of nearly half a mile a minute and to have a ceiling of 30,000 ft. The normal diving speed with brakes extended is 450 m.p.h.

Armor plate protects the pilot, who has two 0.50-caliber guns synchronized to fire through the three-bladed propeller and 0.50-caliber guns in the wings.

Four hydraulically operated dive brakes, one above and one below each wing, were installed to adapt the airplane for dive-bombing tactics. One bomb rack was installed in each wing to hold either bombs or droppable fuel tanks. Other minor changes were made in converting the fighter into a dive bomber. North American Aviation, Inc.

Helicopter Transport Service

A helicopter service to carry air mail and air express to and from the roof tops of over 400 post offices and railroad stations in the six New England states and New York is provided for in an application filed recently with the Civil Aeronautics Board by Northeast Airlines, Inc.

As the helicopter service progresses, it is planned to request authority to carry passengers to and from downtown districts, airports, and suburbs.

Surface Preparation of Metals

A booklet of 20 pages gives detailed information on the surface preparation of metals with Oakite materials and methods, in connection with the finishing of numerous metals, especially black oxide finishing. Formulas are given for the preparation of the solutions and detailed instruction on their use are included. Oakite Products, Inc., New York.

Trans-Gulf Air Route

A new international air transport route, serving the 57,000,000 residents of 19 states in the Ohio and Mississippi Valleys, is planned by the Pan American Airways System across the Gulf of Mexico. The clippers will fly from New Orleans to Guatemala City to connect with the P.A.A. Latin American network.

Passengers from Chicago will be able to reach the Canal Zone, by way of New Orleans, in about 21 hours. Other approximate flying times to the Canal Zone include 24 hours from Minneapolis or St. Paul, 21 hours from Kansas City, and 23 hours from Cleveland; to Guatemala City the schedules show 16 hours, 13 hours and 15 hours, respectively.

From Guatemala, other Pan American Airways routes reach interior Mexico, other Central American republics, the Canal Zone, and into and around the continent of South America. Still others cross the Caribbean to Cuba, the islands of the Greater and Lesser Antilles, and Miami.

The trans-Gulf airway, to be flown by 200-m.p.h., 22-ton, four-engined planes seating 33 passengers in a pressurized compartment for high-altitude operation, lies almost directly north and south on a line drawn through Merida, near

FOR VICTORY
BUY UNITED STATES WAR BONDS AND STAMPS

C26S—Shielded

CHAMPION SPARK PLUGS

have a heritage established by world speed records on land, water and in the air, gained over many years past, which makes them right at home in our fastest fighter planes. Because of their unfailing dependability in life or death situations, Champions are daily gaining new prestige with the men of our air forces.

C26—Unshielded

PERFORMANCE

Our fighter pilots are writing fabulous history. Legendary feats are being reported daily from all combat areas. Their planes are without equal in performance, maneuverability and speed, and they know how to use these qualities to the limit. Champion Spark Plugs play their vital part in an ever increasing number of these planes, as well as in other types used by our Air Forces.

The reasons for the ready acceptance and use of Champions in aircraft engines of every size and type are basic. It is directly due to certain inherent features of design and construction, plus special ceramic insulation with the following exclusive service advantages:

CONSTRUCTION

1. Immunity from heat and chemical reactions.
2. Freedom from fuel, oil, or moisture absorption which causes "shorts".
3. Inherently high heat conductivity with consequent wider range between pre-ignition and fouling.
4. Absolute uniformity of material.
5. Homogeneous structure eliminates air spaces which cause current leakage.
6. Easily cleaned and serviced—no specialized equipment or factory returns necessary.
7. Scientifically controlled manufacture.

USE CHAMPIONS AND FLY WITH CONFIDENCE

the northwest tip of the Yucatan Peninsula.

The new route will bring America's international commercial airway network to almost 100,000 miles, serving more than 60 countries and colonies.

Identification Photograph Unit

The Wim Unit has been designed to meet requirements for identification photographs even though trained personnel is not available to operate the machine. As many as 1,000 pictures can be taken in an eight-hour day. There are 24 exposures on each film roll, and loaded magazines can be inserted in the camera in 7 sec. or less. A fingerprint outfit can be attached to the platform behind the camera. In the Model B unit the principal improvements over the earlier model include a white washable background, self-leveling easel base, increased counterweight capacity, fingerprinting equipment, easily demountable light brackets for increased portability, elevator-ratchet lock, and a choice of size of numbers. Photographic Equipment, Inc., Pittsburgh, Pa.

Instruction Material for Teachers

The Piper Aircraft Corporation, Lock Haven, Pa., has prepared a teacher's kit of junior aviation instruction material to meet a need in the schools for educational material on aviation.

After interviewing school supervisors and classroom instructors to determine the materials best suited for their needs, the kit was developed to include a full-color picture of the Piper Cub L-4 (Army type); airplane nomenclature wal chart; instrument panel nomenclature wall chart; control system nomenclature wall chart; wall chart showing movement of controls and their effect upon attitude of the plane; working blueprint of Piper Cub airplane; full-color Piper catalogue; and a copy of the *You, Too, Can Fly* booklet.

Engineering Fellowships for College Women

A program of special training in selected universities and colleges to prepare young women as engineering aides through the establishment of Pratt & Whitney Aircraft Fellowships was announced by the United Aircraft Corporation's engine-manufacturing division. The program has been extended to the University of Minnesota and North Carolina State College. Other institutions actively cooperating are the University of Connecticut, which has worked closely with the Pratt & Whitney Aircraft engineering departments for several years, the University of New Hampshire, Bucknell University, and Michigan State College.

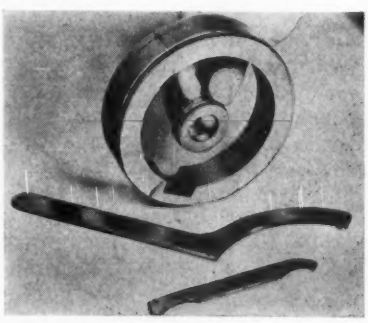
Under the plan each Fellow will receive tuition, books, fees, room, board, laundry, and an allowance to cover incidental expenses. The course of study that will be followed at each school includes mathematics, physics, chemistry, engineering drawing, mechanical laboratory, metallurgy, and industrial engineering and will cover 48 weeks.

This new plan brings into the technical field a training program that Pratt & Whitney Aircraft has been developing since the war emergency began. Many young women already have received special instruction in precision theory and shop practice in the Pratt & Whitney Aircraft training school in Hartford. Others who have had some engineering training are employed in the laboratories and drafting rooms. The Fellowship plan is expected to bring at least 200 more young women with specialized training into the various engineering groups.

Fellowships are being awarded to graduates or seniors who will graduate this June, and juniors who will, by taking a modified schedule, obtain their degrees at the end of four quarters of study starting this June. All Fellows are expected to maintain the scholastic standing necessary to qualify for a degree from the school in which they are enrolled. They agree to a one-year option on their services upon satisfactory completion of the course.

Adjustable Spacing Collars

The Dayton Rogers Manufacturing Company of Minneapolis, Minn., has announced micrometer spacing collars in sizes from $^7/_8$ to $5^1/_2$ in. These adjustable spacing collars are intended to eliminate milling machine cutter arbor shims and give the required positive adjustment for spacing of the straddle mills without removing any of the cutters or collars from the milling machine cutter arbor.



The Dayton Rogers micrometer spacing collar.

A special pin spanner wrench is furnished with each size, making it possible quickly to adjust the spacing collars as to the plus or minus dimension required in connection with the direction indicator engraved on the outer sleeve of the collar.

Plexiglas Cementing Directions

A minor change has been made in the manufacture of Plexiglas sheets. This new material, which has been designated and labeled Plexiglas 1-A, is intended to meet Army and Navy specifications for acrylic plastic sheets. For all practical purposes, it differs from the Plexiglas manufactured previously only in its behavior in cementing and only to the extent indicated.

Cements for Plexiglas fall into five groups: monomer, monomer-solvent cements, partially polymerized monomer, solvent cements, and solvent-polymer cements. Cement 1-A, one of the monomer-solvent type, is recommended by the maker, but, in general, which cement is used will depend on the job at hand, the materials available, and the necessary strength requirements.

Each type is described in detail in a bulletin prepared by the manufacturer, and directions are given for preparing the joint, taping, "soak" cementing, "glue" cementing, and the use of jigs. Rohm & Haas Company, Philadelphia, Pa.

Loading Fork for Heat-Treat Trays

Several of the workers in the plant engineering department of Ryan Aeronautical Company noticed that the heat-treat furnace wore out six heavy steel loading trays per day because of the friction in dragging the white-hot trays in and out of the furnace by hand. They have developed a movable loading fork operated by a chain and crank, which is reported to work so well that a single tray now lasts a full day. It also cuts in half the time needed to load and unload the furnace.

It is indicated that the new idea may save much more steel than the 385 lbs. per day it preserves at Ryan because the new loading fork design will be available without charge to any aircraft company that wishes to use it.

Resistance Meter

The Shallcross No. 915-A megohm decade box is a single dial box, consisting of ten 1.0-megohm resistors, connected in series, mounted on steatite insulators. These resistors are impregnated so that the calibration is not affected by high humidity. Each resistor is capable of dissipating two watts; however, in work requiring closer tolerance the dissipation should be held to 1 watt per unit. The resistors are stated to have a standard accuracy of ± 0.05 per cent at 74°F.

The unit is housed in a metal box and can be furnished completely shielded. It may be immersed in an oil bath for work demanding extreme accuracies, increased dissipation, or both. A maximum of 10,000 volts may be applied across the binding posts. Shallcross

For Continuing Achievement

A STAR FOR WESTON

—evidence that the vital instrument situation rests in good hands!

A star now adorns the ARMY-NAVY "E" pennant awarded to WESTON just 6 months ago . . . the first such pennant awarded in this highly specialized instrument field.

It's a star that has *real meaning*. Because, from the very beginning of our defense period, the responsibility for producing the vast quantities of instruments vital to the success of our country's efforts, has rested largely on the instrument leader.

This star signifies that the responsibility *rests in good hands*. "The men and women of the WESTON Electrical Instrument Corporation," writes the Chairman of the Navy Board for Production Awards, "have achieved a signal honor by continuing their splendid production in such volume as to justify this award . . . indicating their solid determination and ability to support our fighting forces with equipment necessary for victory."

But a great instrument task still remains . . . before victory is ours. So WESTON workers continue reaching for new goals . . . with the same determination, the same painstaking devotion to the quality ideal, responsible for WESTON'S *continuing leadership* in the instrument field.

WESTON ELECTRICAL INSTRUMENT CORPORATION, NEWARK, NEW JERSEY

Manufacturing Company, Collingdale, Pa.

Rod End Bearings

A newly designed self-aligning rod end bearing has been developed to meet the demand of aircraft manufacturers for a rod-end bearing that would stand the vibration of the cowl flaps. It employs an oil-impregnated bearing. These rod ends are furnished in sizes and types interchangeable with most standard ball-bearing type rod ends and can be supplied in nonferrous construction where nonmagnetic material is required. Four standard types are available and other types and sizes can be manufactured to meet special requirements. Simmonds Aerocessories, Inc., New York, N.Y.

Testing Plywood Panels in Shear

Bulletin No. 1431M describes a fixture developed to obtain data on shearing stresses of plywood. It contains illustrations and details on the method of assembling the jig as well as the preparation of the sample and gives engineering data on typical tests and the results determined by these tests for plywood.

The fixture provides means for subjecting a small panel to uniform shearing stress for estimating by tests the seriousness of certain defects that may be present in the plywood. The purpose of the 17-in. square jig is to insure the accurate positioning of the fixture before the specimen for testing is placed on it. The sample is placed over the lower half of the fixture, which has 16 pins spaced around its four sides. The sample has holes drilled at corresponding positions, registering with the pins. The other half of the fixture is then placed over the sample, and eight identical links held to each other by means of hinge pins are put in place to hold the plywood sample securely when bolted into the fixture. An Ames dial mounted on one side of the fixture provides means for determining deflection of the specimen in compression or tension. Two other dials show changes in the lengths of the diagonal. From readings on these dials the shearing strain is estimated. Streeter-Amet Company, Chicago, Ill.

Metal-Parts Cleaning

The Simplex metal-parts washer is offered as an improved automatic unit, designed to replace old methods for cleaning, washing, and preparation of small metal parts, castings, stampings, etc. These units can be used for preparing metals for further machining, for plating, enameling, and other operations. They can also be installed in different departments or in a series—one unit for cleaning, another for rinsing or rust prevention coating, and others for other special requirements.

The cleaning solution is heated to a temperature of 120° to 130°F. by means of steam, electricity, or gas. An electric motor operates a simple lever mechanism that lowers and raises the material tray into and out of the soaking tank.

The Simplex is furnished in three sizes: 36 by 24 by 36 in. (130-gal. capacity); 48 by 36 by 36 in. (265-gal. capacity); and 60 by 48 by 36 in. (450-gal. capacity). Special sizes can be made for special requirements. Sturdy-Bilt Equipment Corporation, West Allis, Wis.

Spring Tester

The manufacturers of Sturtevant torque wrenches announce a new tool for testing compression springs in sizes to $2^1/_2$ in. diameter and 7 in. length. This new tool is planned to make it possible to measure the recoil pressure of a spring when compressed to any predetermined length and to match sets of springs, such as valve springs for internal combustion engines.

The Sturtevant spring tester is operated with any accurate standard torque wrench, the torque wrench not only serving as the operating lever but also providing the measuring element. In this tester a sound device is used to indicate when the spring has been compressed to the test point. Compression of spring is against a rigid platform to prevent accumulated errors in reading.

These tools are being used not only for testing springs of all sorts within their capacity but also for proof-testing strength of press fits and for light arbor-press production operations where they permit the rapid application of accurately gauged pressures.

The tester can be adjusted by regulating the height of the test platform to match the length at which the spring is to be tested. Adjustments to $^1/_{16}$ in. of platform height for test lengths can be read directly. For finer adjustments, one-quarter turn of the platform raises or lowers it $^1/_{64}$ in.—the surface of the platform being marked for readings of $^1/_{64}$, $^1/_{32}$, and $^3/_{64}$ in. For even finer adjustments the periphery of the platform is divided into 21 ridges; these permit adjustments of test lengths to 0.003 in. With platform at desired position and a torque wrench attached, springs are tested by placing them on the platform and pulling down on the wrench. When the point is reached at which the recoil pressure of the spring is to be measured, the tone device sounds and the operator takes his reading from the scale (or dial) on the torque wrench. P. A. Sturtevant Company, Addison, Ill.

Voltage Tester

The Model 590 voltage tester is a portable instrument designed to indicate the character of electric current, the voltage, the frequency, whether an appliance or motor connected in the line is open, which leg is grounded, whether a fuse is blown, and to show excessive leakage between motor and line or when a three-phase motor is running erratically because of a blown fuse. The instrument requires no permanent connections and no outside apparatus. Its dimensions are 5 by $1^3/_4$ by $1^5/_8$ in. Superior Instruments Company, New York, N.Y.

New Fastener for Aircraft Conduit and Piping

A new fastening bracket has been developed to combine a bracket and fastening means in a single stamping. It also permits the use of standard bonding clamps in place of ear-type aluminum bonding clamps in the assembly of conduit and piping in aircraft.

In this new fastening, one or more Speed Nuts are formed as an integral part of the bracket. Another feature claimed for this combination bracket and fastener is that it permits adjustment of conduit or piping at any angle desired with the use of an ordinary screwdriver and reduces assembly time by 50 to 75 per cent. Tinnerman Products, Inc., Cleveland, O.

Projection Equipment

A 16-page booklet titled *Helping You to Get the Utmost from Your Projection Measuring Equipment*, gives information on various types of engineers' transparencies, translucent engineers' glass, inspection charts, and related materials. It shows the methods of developing drawings with glass backings for use with comparators. The features and advantages of these materials are emphasized. The Universal Engraving & Colorplate Company, Buffalo, N.Y.

Charts and Rules

A bulletin titled *Radius Charts & Projector Rules* describes two new developments by a firm that produces glass backed vellum for measuring charts. One is a set of precision radius charts for quick and convenient use on the viewing screens of comparators, micro and contour projectors, and for permanent installations in these instruments. They are illustrated and described in the bulletin.

These charts of radiuses can be supplied in sizes up to $30^3/_4$ by $30^3/_4$ in., square, rectangular or circular in form. They are composed of fine black lines and numerals on the ground surface of plate glass.

SCOVILL
Masters of Metal

TWO "KNOW HOWs" ARE BETTER THAN ONE

"Know how" proof 9... more each month

Your war production or post-war products will be as good as the "know how" (*and* the special or standard *fastenings*) you put into them. The products of your own "know how" will be even better if their standard or special fastening devices are the result of Scovill's many years of experience in Design and Production.

Scovill proves its Fastenings leadership with work, not words. The stud illustrated was made from copper wire by three cold forging operations, plus clipping, drilling, roll-threading. It is but one of the many jobs we have "engineered" into minimum metal—money—motions. And this same "know how" goes into the wide range of standard fastenings we offer.

Scovill Fastenings experts in the offices listed below can help you with the Fastenings end of both your current production problems and your post-war planning. Just as in your own case, we are busy with war work but we will give you a prompt, above-board picture of when and where we can serve you. It will pay you to see what Scovill says.

Mr. Reader: **please route this on to any others in your plant to whom our skill might be of help. Thank you!**

SCOVILL MANUFACTURING COMPANY
WATERVILLE SCREW PRODUCTS DIVISION
WATERVILLE, CONN. TEL. WATERBURY 3-3151

NEW YORK, Chrysler Building • DETROIT, 6432 Cass Avenue • CHICAGO, 1229 W. Washington Boulevard • PHILADELPHIA, 18 W. Chelten Avenue Building
PITTSBURGH, 2882 W. Liberty Ave. • SYRACUSE, Syracuse-Kemper Insurance Bldg. • LOS ANGELES, 2627 S. Soto St. • SAN FRANCISCO, 434 Brannan St.

The other is the Universal projector rule, a convenient accessory in the projection inspection department. All dimensions and numerals are on the under side of the ruler, which permits direct contact of scale proper and object being measured. Fully transparent, with the under side of ground glass carrying thin black graduations and numerals, it is read by either reflected or transmitted light. It is also legible under inspection screen visors and hoods, as well as in darkened projector rooms. The projector rule makes measurements quickly without resetting comparison and measuring projectors. The Universal Engraving & Colorplate Company, Inc., Buffalo, N.Y.

Hydraulic Test Bench

The Voight hydraulic test bench utilizes a simplified arrangement of proved hydraulic principles to test hydraulically operated actuating devices of all kinds. They are individually designed and built to meet testing specifications and production schedules, usually set up by the Army and Navy, providing a range of low pressures for testing operations and high pressures for leak and burst tests.

A typical unit is 5 ft. 6 in. long, 4 ft. wide, 4 ft. 9 in. high, weighing about 1,500 lbs. It has a working surface of perforated steel 3 by 5 ft., large enough to accommodate most fighter craft parts individually or in groups.

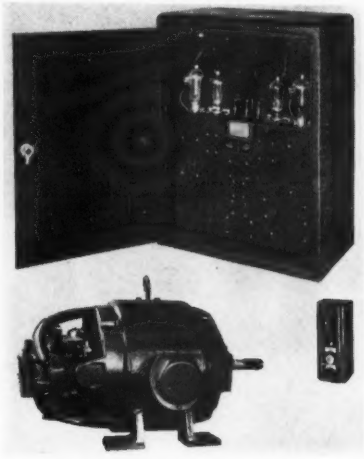
Because of its large liquid circulating system, over 30 gal. per min. under pressure, a group of up to 20 units can be tested simultaneously. R. Voight & Son Company, Buffalo, N.Y.

Airport Runway Lighting Switches

For control of airport runway lighting, a new line of switches including the runway selector switch and the brightness selector switch has been developed by Westinghouse Electric & Manufacturing Company. Similar in appearance and construction, both types incorporate mechanically interlocked preset switches. The two switches are usually a component part of the control desk or panel located in airport control rooms and towers.

The runway selector switch, designed for the selective control of runway contact lights and floodlights, consists of a two-state rotary-type switch having adequate contact capacity to handle all control requirements. Mechanically interlocked with the selector switch are two double-pole, single-throw, preset switches wired to permit the operation of (1) the contact lights along any runways, (2) any group of floodlights, or (3) any group of flood lights and the corresponding runway contact lights, as desired. The mechanical interlocking device locks the selector switch in the position last selected, so that runway selection of flood and contact lights cannot be changed until the selector is de-energized by turning the preset switches to the "off" position, thereby extinguishing contact and floodlights. Where switches are mounted on facsimile maps showing the actual runway layout, the switch handle can be oriented with the map and will point to the actual direction of plane landing or take-off.

The brightness selector switch is a five-position switch for selection of five stages of brilliancy of the runway contact lights. Located adjacent to and mechanically interlocked with this switch is a double-pole, single-throw spring-return latch switch, with spring return to the "lock" position. This device fixes the selector switch in a definite position and locks it in the position of brilliancy last selected until the lock switch is turned to "open" and the contact lights extinguished.



Thyratron tubes supply a shunt-wound d.c. motor with rectified a.c. power in the new Westinghouse Mot-O-Trol electronic motor drive.

Electronic Motor Drive

An adjustable-speed electronic motor drive has been developed for use on applications that require constant preset speed at varying loads over a 20-to-1 speed range, with automatic acceleration and deceleration. It is intended to provide the flexibility of a d.c. motor drive when only a.c. is available. The incoming a.c. power is converted by grid-controlled rectifier tubes and supplied to the armature and field of the d.c. motor. The electronic drive provides constant torque for all speeds up to the base speed of the motor and constant horsepower above base speed.

Thyratron tubes supply a shunt-wound d.c. motor with rectified a.c. power. In general, the system consists of a single or polyphase grid-controlled thyratron tube rectifier that takes power from an a.c. line and rectifies it into d.c. output. The rectified d.c. voltage may be varied from zero to motor-rated voltage or above for d.c. armature control. Smaller thyratron tubes used in the control provide rectified d.c. field current for the motor.

The electronic control for motors of 1 hp. or smaller uses single-phase, full-wave rectification on both field and armature. For motors of larger power rating, a two-phase, full-wave or three-phase, half-wave rectifier may be used. Features of the electronic drive, called the Mot-O-Trol, include stepless speed control, automatic close speed regulation over wide load fluctuations, full torque at low speeds, smooth acceleration and deceleration and dynamic braking. The Mot-O-Trol consists of four parts: the power transformer; the cabinet with thyratron tubes and current-limiting and speed-regulation control; control station with potentiometer and push buttons; and shunt-wound d.c. motor. Westinghouse Electric & Manufacturing Company.

Inspection Expediter

Information is now available on a device for speeding up inspection on production operations within tolerances as close as 0.00005. This new inspection device is the Wilberton Combination Master Surface-Angle Plate, in both bench and floor models, guaranteed within 0.0001 tolerance.

A 4-page bulletin describes the features of the unit, how it is operated, and the advantages to be derived from its use. Thomas Wilberton & Company, Cedar Grove, N.J.

Sub-Zero Wind Tunnel

The new wind tunnel to be built at Wright Field will have refrigeration equipment produced by York Ice Machinery Corporation which is claimed to develop a temperature of 67° below zero. The equipment is designed to produce more than 4,000,000 cu.ft. of refrigerated air per minute. The air blast through the tunnel will pass over a network of cooling coils chilled by as much as 8,000 tons of refrigeration and the accelerated velocity of the air stream is expected to cause the temperature drop to 67° below zero by the time the air stream reaches the throat of the tunnel. Decompression pumps will evacuate the air until the pressure is reduced to less than 2.7 lbs. per sq.in., approximately that found at altitudes above 40,000 ft. It is contemplated that the extreme temperature of 67° below zero can be maintained for one hour or longer before the tanks must be recooled.

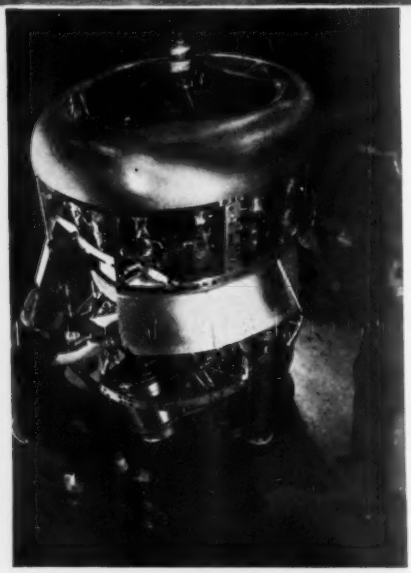
ROHR

PARTS ☆ ASSEMBLIES

"Get thar Fustest with the Mostest!"

Expressive phrase of a famous Confederate fighter

LOCKHEED CONSTELLATION



BUILD 'em *bigger,* fly 'em *faster,* do it *first* and do it in *quantity*--America's axiom for supremacy of the air! No goal in American history was ever more urgent! ROHR production fighters force their tasks of precision parts manufacture and vital assemblies toward this end. ROHR-equipped air giants fly to battle in ever increasing numbers, rushed there by the men and women on production lines who know that *speed saves lives*!

HELPING TO WRITE
THE STORY OF TOMORROW

ROHR AIRCRAFT CORPORATION — *CHULA VISTA, CALIFORNIA*

Institute News

National Aircraft War Production Council, Inc.

National Aircraft War Production Council, Inc., was formed recently to provide liaison between the Aircraft War Production Council, Inc., and the Aircraft War Production Council East Coast, Inc. The new organization is described as a "factual filter" to interchange experience and ideas in the various phases of manufacturing and engineering between the factories on the east coast and west coast and also to give factual information to the War Production Board and the armed services. The national council will have offices in Washington and will fill the need for a central channeling agency for interchanging information among members.

Glenn L. Martin, President of The Glenn L. Martin Company, is President of the national body, and Lamotte T. Cohu, Chairman of the Board of Northrop Aircraft, Inc., is Vice-President. Frank F. Russell, President of National Aircraft Corporation, is General Manager.

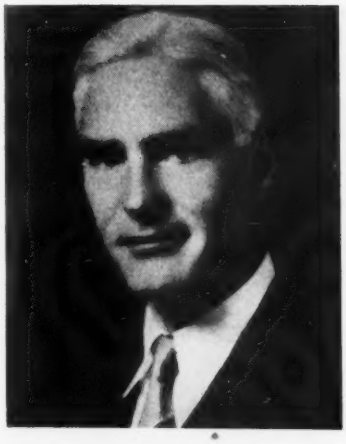
The National Aircraft War Production Council, Inc., includes in its membership those of the two regional councils, including: The Aviation Corporation, Bell Aircraft Corporation, Boeing Aircraft Company, Brewster Aeronautical Corporation, Consolidated Vultee Aircraft Corporation, Curtiss-Wright Corporation, Douglas Aircraft Company, Eastern Aircraft Division of General Motors, Fairchild Engine & Airplane Corporation, The Glenn L. Martin Company, Lockheed Aircraft Corporation, North American Aviation, Northrop Aircraft, Inc., Republic Aviation Corporation, Ryan Aeronautical Company, and Vega Aircraft Corporation.

Aircraft War Production Council, East Coast, Inc.

J. Carlton Ward, Jr., President of Fairchild Engine & Airplane Corporation, was elected President of the Aircraft War Production Council, East Coast, Inc., at the regular April meeting, to succeed Glenn L. Martin. Lawrence D. Bell, President of Bell Aircraft Corporation was elected Vice-President of the Council.

The Aircraft War Production Council, East Coast, Inc., is cooperating with the Aircraft War Production Council, Inc., in the organization of the National Aircraft War Production Council, Inc., formed recently to coordinate the activities of the two councils which operate, respectively, as liaison units between groups of aircraft manufacturers in the eastern part of the United States and on the Pacific coast.

Glenn L. Martin.



J. Carlton Ward, Jr.

E. R. Breech.

Central Aircraft Council

The formation of a Central Aircraft Council has been announced. The new organization will have headquarters in Detroit and will sponsor activities similar to those of the Aircraft War Production Council and the Aircraft War Production Council, East Coast, Inc., each of which comprises a group of leading aircraft manufacturers. The central organization will differ from the others, however, to the extent that it will include the manufacturers of aircraft engines, air frames, and components, such as propellers, landing gear, carburetors, instruments, and other accessories. Ernest R. Breech is President of the new central council.

New Corporate Members

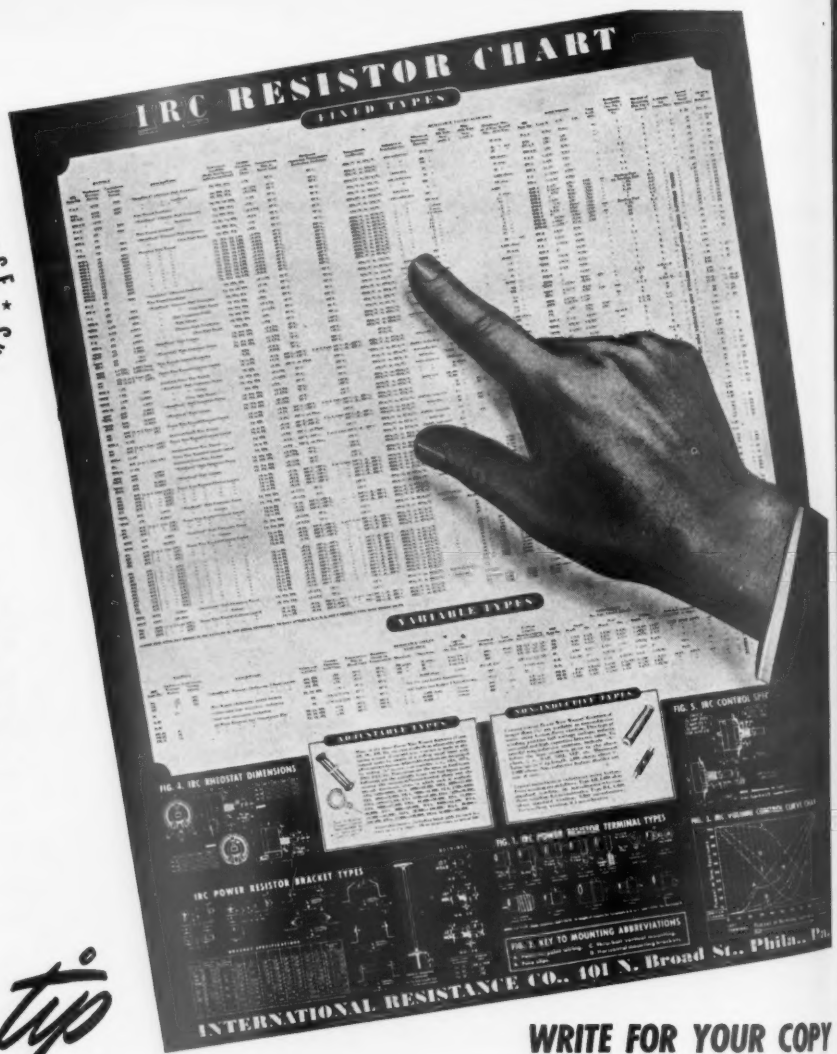
During the past month the following companies have become corporate members of the Institute:

Culver Aircraft Corporation has been engaged for the past two years in the development of an experimental project for the Army and the Navy. The company is now devoting its total efforts to the war program and is giving considerable attention to the commercial situation after the war. It is planning to maintain its position in the civil aircraft business with a fast and safe light airplane as soon as its facilities can again be directed to private business.

The Weston Electrical Instrument Corporation made the ammeters used in connection with the Liberty engines during the first World War. Another of its early aeronautical applications was the replacement of mechanical tachometers by Weston Electrical Tachometers. This was followed by engine synchronizing indicators.

Other initial commercial applications of Weston Instruments were the cross pointer blind landing indicators, electrodynamometer direction finding in-

PREFERRED FOR PERFORMANCE
IRC
FIXED & VARIABLE RESISTORS


IRC RESISTOR CHART
FIXED TYPES
VARIABLE TYPES
ADJUSTABLE TYPES
NON-INDUCTIVE TYPES
FIG. 2. IRC RHEOSTAT DIMENSIONS
FIG. 5. IRC CONTROL
IRC POWER RESISTOR BRACKET TYPES
FIG. 1. IRC POWER RESISTOR TERMINAL TYPES
FIG. 3. KEY TO MOUNTING ABBREVIATIONS
INTERNATIONAL RESISTANCE CO., 401 N. Broad St., Phila., Pa.

COMPLETE RESISTOR DATA at your finger tip

WRITE FOR YOUR COPY OF THIS HANDY CHART TODAY

Developed under the direction of IRC's engineering staff as a technical reference for those interested in the design and study of applied electronics, you'll find this Chart a valuable time-saver. In easy-to-read tabular form are listed the essential data on over 122 sizes in 18 standard IRC types of fixed and variable resistors. At a glance you can determine such information as wattage and voltage ratings, dimensions, resistance values, terminals, mountings, inductive characteristics, temperature rises, maximum operating temperatures and temperature coefficients as well as Resistor Color Code, Preferred Number System and other important data. In short, the Resistor Chart will help you select the right resistor for the job at hand, with a minimum of effort. Compact, the Chart is adaptable to wall or desk use and folds to standard file size. We suggest that you send in your request for the Charts you can use to advantage. There is no obligation, of course.

INTERNATIONAL RESISTANCE COMPANY

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dicators, voltmeters, and radio frequency ammeters for aeronautical applications. Weston designed thermocouple thermometers for measuring engine temperatures and resistance thermometers for oil, air, coolant, and carbureter temperatures, as well as single and dual ratiometers and bridge types. Among the later aeronautical instruments produced are position indicators, frequency meters, and terrain indicators.

Gifts to the Aeronautical Archives

Gifts of books for the month included five sets of Durand's *Aerodynamic Theory*, from the Durand Reprint Committee of the California Institute of Technology. Mr. Fred C. Kelly gave a copy of A. Brigole's *Santos Dumont, o pioneiro do ar*, published by the Aero Club do Brasil in 1942. Mr. A. Leo Stevens gave additional newspapers and magazines of great value. Dr. Frederick Bedell gave copies of two of his books, *Airplane Characteristics*, Ithaca, N.Y., 1918, and *The Air Propeller*, N.Y., 1919. Mr. Jack Vilas gave two copies of *My Life to My Children*, his autobiography which was privately printed in 1934. Mr. Paul H. Wilkinson gave a number of catalogues, pamphlets, and periodicals, both European and American, dealing with aircraft, engines and armament, and a copy of *A.M. Fuel Systems for Aircraft*, by Basile Demtchenko, translated from the French by M. E. Boname and published in Paris in 1938. The Soaring Society of America, through Mr. Alexis Dawydoff, gave a number of copies of its journal, *Soaring*. The British Air Commission in Washington added some two dozen R.T.P. Translations to the large collection previously given.

From Pan American-Grace Airways the Archives received a complete set of the insignia of Panagra and L.A.B., specially prepared in a leather folding case. The Douglas Aircraft Company, Inc., gave 26 aeronautical posters and five reproductions of prints, and a copy of "Out of the Sky," the official song of the company.

The Boeing Aircraft Company gave an alert phonograph record, used for air-raid drills and three prints of the Flying Fortress, in addition to company insignia. The large collection of insignia in the Archives will be considerably more than doubled by gifts that are arriving at the present time through the generosity of the aircraft companies. This increase in the collection will be described in a later number of the AERONAUTICAL ENGINEERING REVIEW.

Sections and Branches

Detroit Section

The Detroit Section held a combined meeting with the Engineering Society of Detroit on the evening of March 23, 1943. A talk was presented by J. Parker Van Zandt on "Civil Aviation Goes to War," which was illustrated by a technicolor film. The film portrayed the operation of transport planes before and during the war. Other pictures were shown on some of the newer developments in aeronautics, such as glider trains and helicopters. About 700 members and guests attended the lecture.

Seattle Section

On January 27, 1943, the Section listened to a talk by Col. A. L. Harvey of the Army Air Forces on his flight around the world in 1942. Colonel Harvey told how he was in command of an Army bomber that flew a British Air Mission to Moscow via Archangel. The flight later continued to Baghdad, Karichi, Calcutta, Rangoon, Singapore, Darwin, Port Moresby, Wake Island, and Honolulu to San Francisco. Colonel Harvey also told of another flight over the Arctic to Moscow in 1942 to determine the feasibility of an air route over Siberia.

On March 24, 1943, George S. Schairer, Chief Aerodynamicist of Boeing Aircraft Company, delivered the paper on "Flight Testing for Performance and Stability," which had been presented by the late Edmund T. Allen as the Wright Brothers Lecture on December 17, 1942.

Alabama Polytechnic Institute

Newly elected officers for the Alabama Student Branch include Bill Cohen, Chairman; Arthur R. Romanos, Vice-President; and Eliah P. Perlman, Secretary-Treasurer.

Casey Jones School of Aeronautics

At a regular meeting of the Student Branch on March 18 the program committee presented two sound motion pictures, *Aerial Navigation* prepared by the U.S. Army Signal Corps, and *Thermodynamics*, an Erpi Classroom Film.

At a meeting on April 1, 1943, H. E. Linsley of the Wright Aeronautical Corporation presented the sound film *Power by Wright*, showing in considerable detail the manufacturing processes involved in the building of the Wright Cyclone 14 from the foundry, through the machine shops, to the final assembly and test.

Indiana Technical College

The Indiana Technical College Student Branch held its regular term meeting and banquet on February 21, 1943. The following new officers were elected: Harold Hollenberg, Chairman; J. R. English, Vice-Chairman; Nickolas Motlowitz, Secretary; and Ralph Wilcox, Treasurer. Wendell Lowry will continue as Honorary Chairman. A talk was presented by Mr. Schults, of the faculty of the college, on his experiences in the Naval aviation service, and Capt. I. W. Baldwin, of the Civil Air Patrol, spoke about the activities of his organization.

The new chairman presided at the meeting on March 15. A committee was appointed to take care of the selection of books on aeronautics for the library. After the adjournment of the meeting a film was shown on Plexiglas.

Committees were appointed at the meeting on March 29 to take care of the subjects of books, motion pictures, membership, papers and meetings, and refreshments. A general discussion followed about books and the presentation of future papers. A film on landing gear was shown at the conclusion of the meeting.

At a meeting on April 12, a financial report was presented, followed by a discussion of plans for cooperating with the Mechanical Club. Paul Steele presented an informative talk on the personnel arrangements and duties at Wright Field.

North Carolina State College

New officers were elected on March 3 as follows: Chairman, Cliff Spruill, Jr.; Vice-Chairman, Dave Michal; Secretary-Treasurer, Roy Hayes; Recording Secretary, Braxton Young; Reporter, Thurman Kenyon; Representative, M. B. Dunn; Alternate Representative, Charles Hinnant; Faculty Adviser, Prof. R. F. Rautenstrauch.

Oklahoma A. and M. College

The program for the meeting on March 25, 1943, included a talk by Allen Spangler on the increasing importance of the heavy bomber. He concluded his talk with a survey of some of the newer military aircraft.

Oklahoma University

Thirty members of the Oklahoma University Student Branch made an inspection trip to the Oklahoma City

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Trade School where men are trained for the Army Midwest Depot. Radial and in-line engines were inspected in various stages of disassembly and their operation was explained by guides who answered questions. An opportunity was presented to the members to make a close examination of a P-38, a P-40, a B-26, an A-20, and several other planes. The trip had been planned at the last regular business meeting in March, at which time the film *Target for Tonight* was shown.

Polytechnic Institute of Brooklyn

New officers of the Evening Student Branch are as follows: Chairman, Edward Stoltz, Jr.; Vice-Chairman, William Mosconi; Treasurer and Secretary, Harold Rosen; Honorary Chairman, R. P. Harrington. At a meeting on April 1, Mr. Z. Krzywoblocki gave a talk on rocket propulsion. On April 7, a joint meeting with the Day Student Branch witnessed the showing of films on the Wright engine.

Virginia Polytechnic Institute

The following are the new officers of the Virginia Polytechnic Institute Branch: Chairman, R. S. Hess; Vice-Chairman, R. L. Bryant; Secretary, E. G. Snyder; Treasurer, C. C. Arthur; Honorary Chairman, Prof. L. Z. Seltzer.

News of I.Ae.S. Members

Peter Altman has resigned as Director of the Manufacturing Research Department of Vultee Aircraft, to form a consulting and development service with officers in Detroit.

Paul S. Baker has been appointed as Engineering Manager at the Chance Vought Aircraft Division of United Aircraft Corporation. He had been the head of the Aerodynamics and Flight Test Section at Chance Vought since 1939.

Leroy D. Barter entered the service of the United States Government in Civilian Public Service work.

Wellwood E. Beall was elected Vice-President in Charge of Engineering of Boeing Aircraft Company. He was formerly Chief Engineer.

Lawrence D. Bell, President of Bell Aircraft Corporation, is Vice-President of the Aircraft War Production Council, East Coast, Inc., and a Director of the new National Aircraft War Production Council, Inc.

Guiseppe M. Bellanca was elected as Chairman of the Board of Directors of Bellanca Aircraft Corporation at a recent election in connection with other changes in the executive personnel of the company. He is also Consulting Aeronautical Engineer and Designer for Higgins Industries, Inc.

Ernest R. Breech, President of the Aviation Corporation, has announced the formation of a Central Aircraft Council, composed of leading aircraft concerns in the central states, to perform functions similar to those of the east and west coast councils.

Ben G. Bromberg is Chief Structural Engineer in the newly combined Consolidated Vultee Aircraft Corporation. He was formerly Stress Engineer at Vultee Aircraft, Inc.

John A. Carran, formerly Flight Test Engineer, has joined the C.A.A. Flight Engineering and Factory Inspection Division as a Flight Test Analyst.

Delmar H. Chitwood has entered the U.S. Army Air Forces as a Flying Cadet. He was a Stress Analyst at Cessna Aircraft Company.

Lamotte T. Cohu, Chairman of the Board of Northrop Aircraft, Inc., is Vice-President of the new National Aircraft War Production Council, Inc.

Morris A. Garbell was appointed Senior Aeronautical Design Engineer at Consolidated Vultee Aircraft Corporation. He was formerly an instructor at the Boeing School of Aeronautics.

Hubert N. Harmon is now Associate Aeronautical Engineer at the Aircraft Engineering Research Laboratories of the N.A.C.A.

Edwin R. Hawley, formerly a designer at Consolidated Vultee Aircraft Corporation, has become Senior Liaison Engineer at the Arizona Division of Goodyear Aircraft Corporation.

William P. Heinen, Jr., is now connected with Grumman Aircraft Corporation having formerly been with the Langley Memorial Aeronautical Laboratory of the N.A.C.A.

Jack S. Joanides has recently joined Douglas Aircraft Company, Inc.

Col. John H. Jouett has been elected President of Bellanca Aircraft Corporation.

Douglas A. King has been promoted from Junior to Assistant Aeronautical Engineer in the Hydrodynamics Division of the Langley Memorial Aeronautical Laboratory.

Ernest Korbin has joined the Linden Division of the Eastern Aircraft Division of General Motors.

Ali U. Kutsay was recently appointed Stress Analyst at the Buffalo Plant of Curtiss-Wright Corporation.

Clinton B. F. Macauley, formerly Managing Editor of *Aviation* magazine, is now Editor of the magazine *Air Tech.*

Glenn L. Martin, President of The Glenn L. Martin Company, is President of the newly formed National Aircraft War Production Council, Inc.

Irving D. Melker joined General Aircraft Corporation as Stress Engineer.

Pierre E. Mercier has joined Electro-Mechanical Research, Inc., as Consulting Engineer. He was formerly Consulting Engineer at General Aircraft Equipment, Inc.

Roy G. Miller was promoted to Executive Assistant to Chief Engineer of the Curtiss-Wright Corporation, Buffalo Plant.

Bruce Mitchell has advanced to Senior Stress Analyst with Consolidated Vultee Aircraft Corporation.

Parameswar Nilakantan has been appointed Aerodynamicist in the Engineering Department at Hughes Aircraft Company.

William A. Oconnicof was promoted from Liaison Engineer to Flight Test Engineer at Consolidated Vultee Aircraft Corporation.

Albert C. Reed has taken over supervision of Engineering Flight Testing at Boeing Aircraft Company, succeeding the late Edmund T. Allen.

Frank F. Russell, President of National Aviation Corporation, is General Manager of the new National Aircraft War Production Council, Inc.

Comdr. Albert B. Scoles has been assigned to the staff of the Commander, Air Force, Pacific Fleet, U.S. Navy.

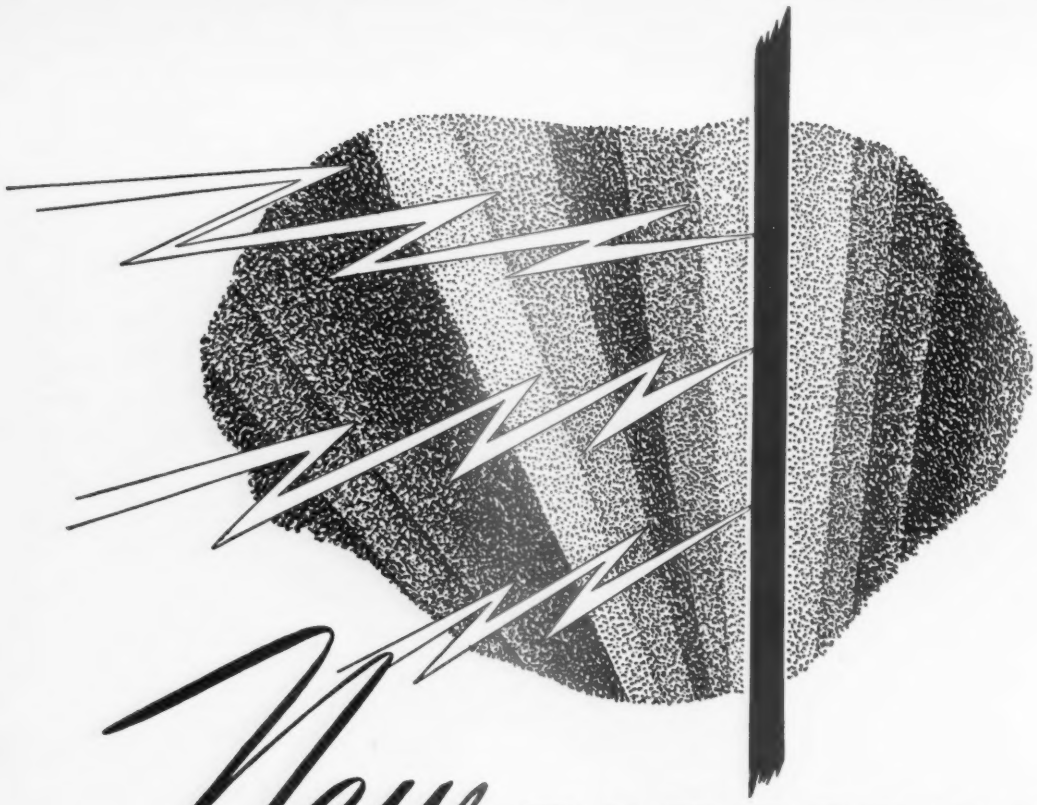
Benjamin C. Scott, Jr., has enlisted in the U.S. Navy and is undergoing training as an Aerial Navigator.

James M. Shoemaker has been advanced to Chief Engineer of the Chance Vought Aircraft Division of United Aircraft Corporation. He was formerly Assistant Chief Engineer.

J. Carlton Ward, Jr., President of the Fairchild Engine & Airplane Corporation was elected President of the Aircraft War Production Council, East Coast, Inc., succeeding Glenn L. Martin. Mr. Ward is also a Director of the National Aircraft War Production Council, Inc.

Leslie W. Westerling, Jr., has joined Waco Aircraft Company.

Samuel Yudewitz is now engaged in products study and aircraft development with General Motors Corporation.



New BARRIERS to Confine Electric Current!

War is destructive but not all effort that goes into the big fight is wasted. Some of it is going to pay mighty big future dividends. That is especially true of the war work that is going on in the country's laboratories.

At Formica this work has resulted in the development of some new insulating materials with new and valuable characteristics which will be doing important jobs in American electrical products long after the war is over.

Three new grades MF, FF-10 and FF-41 accomplish things that could not be done previously with this laminated insulation. MF is a glass mat base for applications requiring low loss at radio frequencies (Power Factor .011; Dielectric Constant 4.6; Loss Factor 0.05 at 1 Megacycle).

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These materials have a new and important usefulness. At present they are available only for the most essential war uses. But later they will be widely applied.

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Members Elected

The following applicants for membership or applicants for change of previous grade have been admitted to membership in the grades indicated since the publication of the list in the last issue of the REVIEW.

Elected to MEMBER Grade

Berry, James Dean, Base Technical Inspector, U.S. Army Air Forces.

Blanchard, W. J., B.S. in M.E.; General Manager, Aeroproducts Div., General Motors Corp.

Coates, Raymond Walter, Chief Draftsman, Sikorsky Aircraft Div., United Aircraft Corp.

Collins, Leighton Holden, LLB., Editor, Air Facts, Inc.

Cooper, Homer Vernon, Jr., B.S. in Ae.E.; Sr. Flight Test Engineer, The Glenn L. Martin Co.

Crockett, Cecil Leslie, Jr., B.S. in M.E.; Stress Analysis Engineer, Vega Aircraft Corp.

Dashefsky, Edward L., B.S. in Ae.; Aero. Engineer, Airplane Div., Curtiss-Wright Corp.

Forster, Walter John, Staff Engineer, Curtiss-Wright Corp.

Godsey, Frank Waldman, Jr., E.E.; Staff Engineer, Westinghouse Electric & Manufacturing Co.

Gorfin, Alex., Engineer, Mechanical Research Dept., Matam Corp.

Kartveli, Alexander, Vice-President & Chief Engineer, Republic Aviation Corp.

McLean, Kenneth J., E.E.; District Aircraft Engineer, General Electric Co.

Mulé, Anthony Frank, B.S. in M.E.; Fuselage Liaison Engineer, Brewster Aeronautical Corp.

Nowakowski, Zygmunt J., Chief Tool Designer, Massey Harris Co., Ltd., Canada.

Pepper, Perry Arnold, Dr. Eng. Sci., Aerodynamicist, Eastern Aircraft Div., General Motors Corp.

Rabnett, Basil, B.Ae. in M.E.; Engineer Officer, R.C.A.F. Headquarters.

Richardson, Orville Leighton, B.M.E.; Aerodynamicist, The Glenn L. Martin Co.

Robinson, Hugh Stuart, M.E.; Project Engineer, Bendix Products Div., Bendix Aviation Corp.

Rollings, William Pearson, B.S. in Ae.S. & M.E.; Structures Engineer, Bell Aircraft Corp.

Salter, Colenso John, B.A.Sc.; Chief Engineer, Teleflex, Ltd., Canada.

Skrobisch, Alfred, E.E.; Chief Research Engineer, Eastern Air Devices, Inc.

Smith, Stanley Wilson, B.S. in Ae.E.; Project Stress Engineer, Bell Aircraft Corp.

Thaw, Russell William, Chief Test Pilot, Airplane Div., Curtiss-Wright Corp.

Young, Willard Vincent, M.S. in M.E.; Professor of Mechanical Engineering, Oklahoma A. & M. College.

Transferred to MEMBER Grade

Hotson, John H., Pilot, Dominion Skyways Ltd., Canada.

Schram, Richard Arney, Lt. (j.g.), Engineering Officer, U.S. Navy.

Elected to Industrial Member Grade

Burnstan, Rowland, Ph.D., Sc.D.; Director, Aero. Div., Minneapolis-Honeywell Regulator Co.

Lee, Ivy Ledbetter, Jr., B.A.; Asst. to Div. Mgr., Africa-Orient Div., Pan American Airways System.

Stricker, Adam K., Jr., B.S.; Temporary: Principal Administrative Officer, Signal Corps, H.Q. Services of Supply, War Dept.; Permanent: Chairman's Staff, General Motors Corp.

Elected to Technical Member Grade

Allen, George T., Engineer, Simmonds Aerocessories, Inc.

Anthony, Riley Edward, Jr., B.S. in M.E.; Charge Resistance Welding Eng. & Development, Goodyear Aircraft Corp.

Broz, Albert Frank, Design Engineer, Bendix Aviation Ltd.

De Lorenzi, Ezio Peter, Stress Analyst, Bell Aircraft Corp.

Gardner, Ray David, Jr., Group Engineer Fuselage, Higgins Aircraft Inc.

Ice, Ely Hartzell, Layout Engineer, Higgins Aircraft, Inc.

Judd, Frederick Van Horn, B.S.; Aero. Engineer, United Aircraft Corp.

Keiter, Floyd Grantham, B.S. in Ae.E.; Stress Engineer, Wichita Div., Boeing Airplane Co.

Kirkwood, Charles Clemons, Minor Layout Draftsman, Consolidated Vultee Aircraft Corp.

Lardie, Warren George, Flight Research Engineer, Bell Aircraft Corp.

Leach, Sam Leslie, Drafting Supervisor, Airplane Div., Curtiss-Wright Corp.

Le Vesque, Russell Joeson, Standards Engineer, Hughes Aircraft Co.

Lorence, Herman Ringler, Jr., Stress Analyst, Bell Aircraft Corp.

Lowry, Wendell Willis, B.S. in Ae.E.; Instructor, Indiana Technical College.

Meole, Charles N., B.S. in Ed.; Asst. Instructor War Dept., U.S. Army Air Forces Technical School.

Moore, Dwight Morris, B.S. in M.E.; Service Engineer, Consolidated Vultee Aircraft Corp.

Moretti, Daniel D., B.S. in Ae.E.; Engineering Instructor, Casey Jones School of Aeronautics.

Murlin, John Anderson, M.E.; Stress & Structures Engineer, Bell Aircraft Corp.

Peters, Alexander, Weight & Balance Engineer, York Aircraft Corp., Inc.; Weight Engineer, S.A.W.E.

Rane, John William, Jr., B.S. in C.E.; Stress Engineer, Bell Aircraft Corp.

Rogers, John D., Jr., M.S.; Asst. Project Engineer, Wright Aeronautical Corp.

Rosenthal, Edward Max, E.E.; Service Engineer, Aircraft Development, General Motors Corp.

Sheffield, Harold Blair, B.S. in M.E.; Stress Analyst, Consolidated Vultee Aircraft, Inc.

Shreve, Darrell Rhea, Ph.D.; Asst. Stress Analyst, McDonnell Aircraft Corp.

Speaker, Robert Francis, B.S.E.; Stress Analyst, Airplane Div., Curtiss-Wright Corp.

Suchner, Donald Reinhold, Test Pilot, Airplane Div., Curtiss-Wright Corp.

Wegmann, John, Jr., Group Checker, Engineering Dept., Fort Worth Div., Consolidated Vultee Aircraft Corp.

Transferred from Student to Technical Member Grade

Aginsky, Milton, B.S. in Ae.E.; Engineer Corps, U.S. Army.

Anderson, Vern Albin, B.S. in M.E.; Aerodynamicist, Airplane Div., Curtiss-Wright Corp.

Angell, Donald Willard, B.S.E.; Stress Analyst, Bell Aircraft Corp.

Berlin, Daniel, Ae.E.; Stress Analyst, Airplane Div., Curtiss-Wright Corp.

Benner, James Robert, B.S. in Ae.E.; Jr. Engineer, Douglas Aircraft Co., Inc.

Blalock, James Emory, B.Ae.E.; Jr. Aero. Engineer, Dept. of Aeronautics, Navy Yard, Washington, D.C.

Boggs, James Harlow, Jr., B.S. in M.E.

Booher, Karl Wilson, B.S. in Ae.E.; Aero. Engineer, Airplane Div., Curtiss-Wright Corp.

Borst, Henry Vroman, B.S. in Ae.E.; Student Engineer, Propeller Div., Curtiss-Wright Corp.

Boyd, Walter Anderson, Jr., B.S. in Ae.E.; Ensign, U.S. Navy.

Brick, Julius, B.Ae.E.; Aviation Cadet, U.S. Army Air Forces.

Champine, Robert Apgar, B.Ae.E.; Ensign, U.S. Navy.

Chase, Thomas Weaver, B.Ae.E.; Ensign, A-V(P), U.S.N.R.

Cherne, Jack M., Draftsman, Stress Dept., The Glenn L. Martin Co.

Cheung, Lam-Tai, B.S. in M.E.; Structural Engineer, Consolidated Vultee Aircraft Corp.

Clark, Gene Weldon, B.S.; Engineer, Pan American Airways System.

Crumrine, Herbert Ellsworth, B.S.E.; Aviation Cadet, U.S. Army Air Forces.

de Medeiros, Carlos Alberto Viriato, A.E.

Doerlich, Charles, Jr., Designer, Fairchild Aircraft Corp.

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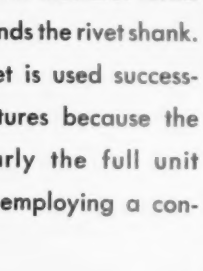

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Flat and Molded Weldwood for fuselages, wing-tips, flaps, tail assemblies, etc. is hot-press phenolic resin-bonded and conforms with Army and Navy Specification AN-NN-P-511a. It is water-, rot-, fungus- and bacteria-proof and has a favorable strength/weight ratio.

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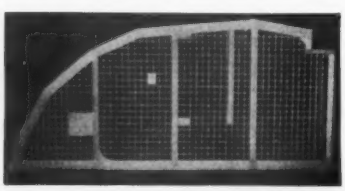
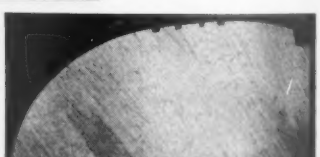
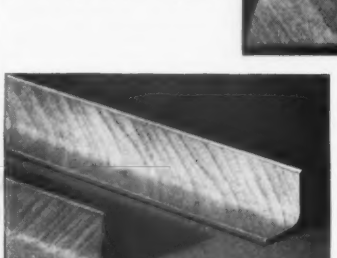


Hollow core of panel for bomber floor board, showing light-weight construction of exceptional strength.

Face of panel, made of Aircraft Weldwood, which is permanently bonded to top and bottom of core.





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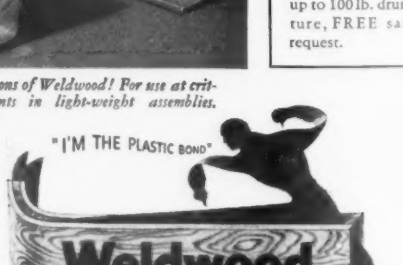

PLASTICS AND WOOD WELDED FOR GOOD

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Dunkelberger, Neil Elwood, B.S. in Ae.E.; Jr. Engineer, Research Dept., Curtiss-Wright Corp.

Fickett, Earl Anthony, Engineer, Republic Aircraft Corp.

Fiedler, Henry, A.E.; Officer Candidate, U.S. Army Air Forces.

Foner, David Newton, B.S. in M.E.; Jr. Aero. Engineer, Naval Aircraft Factory, Navy Yard, Philadelphia.

Forsten, Irving, B.S.; Apprentice Engineer, Grumman Aircraft Engineering Corp.

Galaida, Stephen, Engineering Cadet, U.S. Army Air Forces.

Gazzo, Salvatore Fred, Stress Analyst, Fairchild Aircraft Div., Fairchild Engine & Airplane Corp.

Gean, James Arthur, M.S. in Ae.E.; Stress Engineer, Sikorsky Aircraft Div., United Aircraft Corp.

Geiger, Robert Charles.

Geiger, Werner Hugo, U.S. Army.

Gerard, George, B.Ae.E.; Jr. Research Engineer, Republic Aviation Corp.

Gerber, Robert William, B.S. in Ae.E.; Jr. Engineer, Douglas Aircraft Co., Inc.

Gotsch, John Joseph, Aero. Engineer, Fairchild Aircraft Div., Fairchild Engine & Airplane Co.

Graves, William Edward, B.S. in Ae.E.; Power Plant Engineer, Douglas Aircraft Co., Inc.

Grossman, Norman, B.Ae.E.; Jr. Research Engineer, Republic Aviation Corp.

Gurin, Peter Joseph, B.S. in Ae.E.; Ensign, U.S. Navy Air Corps.

Head, Robert Eugene, B.S. in M.E.; Aerodynamicist, Fleetwings, Inc.

Hedrick, William Sutter, B.S. in M.E.; Jr. Engineer, Ames Aero. Lab., N.A.C.A.

Hewes, Robert Earl, Flight Test Engineer, Consolidated Vultee Aircraft Corp.

Hill, Bob Freeman, B.Ae.E.; Ensign, U.S.N.R.

Johnson, Arne Inbfar, B.S. in Ae.E.; Structural Engineer, Willow Run Plant, Ford Motor Co.

Jones, Charles Sherman, Jr., S.B. in Ae.E.; Engineer, Fairchild Aircraft Div., Fairchild Engine & Airplane Co.

Keller, Thomas Loucks, B.Ae.E.; Jr. Engineer, Ames Aero. Lab., N.A.C.A.

Kleber, John A., B.S. in M.E.; Jr. Engineer, Airplane Div., Curtiss-Wright Corp.

Kroupa, Charles Emil, B.Ae.E.

Landon, Robert Benson, B.Ae.E.; Instrumentation Engineer, Chance Vought Aircraft Div., United Aircraft Corp.

Lehmkuhl, Joel Carl, Ae.E.

Lenz, Ralph Charles, Jr., Ae.E.; Tool Engineer, The Glenn L. Martin-Nebraska Co.

Masaki, Mamoru, B.S. in M.E.

McMaster, Spencer Rice, Jr., B.S. in M.E.; Ensign, U.S.N.R.

McMillin, Claude Harding, B.S. in Ae.E.; Jr. Engineer, Airplane Div., Curtiss-Wright Corp.

Meyn, Theodore William John, Special Apprentice Engineer, Pan American Airways System.

Miller, Mahlon Albert, B.S. in M.E.; Jr. Engineer, Aircraft Engine Research Lab., N.A.C.A.

Miller, Robert William, B.A.E.; Jr. Engineer, Langley Mem. Aero. Lab., N.A.C.A.

Millie, John Henry, B.S. in Ae.E.; Asst. Chief Draftsman, Victory Aircraft Ltd., Canada.

Nunziato, Ralph Joseph, B.Ae.E.; Lt., U.S. Army Air Forces.

Pappas, Alexander, Stress Analyst, Fairchild Aircraft Div., Fairchild Engine & Airplane Corp.

Popowich, George, B.S. in Ae.E.; Stress Analyst, Taylorcraft Aviation Corp.

Rosenblom, David, B.Ae.E.; Private, U.S. Army Air Forces.

Rush, Charles Noel, B.S.E.; Aviation Cadet, Army Air Forces Technical School.

Samet, Arthur Herman, Stress Analyst, Fairchild Aircraft Div., Fairchild Engine & Airplane Corp.

Scarborough, John Lewis, Jr., B.Ae.E.; Instructor, Engineering, Sciences & Management War Training, Alabama Poly. Inst.

Schmitt, James Walter, U.S. Army.

Seckel, Edward, B.S. in Ae.E.; Aerodynamicist, Fleetwings, Inc.

Sisler, Carlton Elliott, Jr., B.S. in Ae.E.; Detail Draftsman, Douglas Aircraft Co., Inc.

Slaymaker, Samuel Evans, III, B.S.E.; Research Assoc., School of Engineering, Princeton Univ.

Smith, Donald William, B.Ae.E.; Instructor, Rensselaer Poly. Inst.

Spangler, Theodore Allen, B.M.E.; Engineer, Boeing Aircraft Corp.

Stajich, Maks Alfred, Designer, Fairchild Aircraft Div., Fairchild Engine & Airplane Corp.

Stetson, John Charles.

Strassman, Alfred Bernard, B.A.E.; Jr. Aero. Engineer, Naval Aircraft Factory, Philadelphia.

Studley, Henry Jean, B.A.E.

Stumpf, Lawrence Rodney, B.S. in Ae.E.; Stress Analyst, Douglas Aircraft Co., Inc.

Tankersley, George, B.Ae.E.

Truman, John Carlton, B.Ae.E.; Aviation Cadet, U.S. Army Air Forces.

Ulichny, Edwin Edward, Test Laboratory Engineer, Fairchild Aircraft Div., Fairchild Engine & Airplane Corp.

Ulmer, Stanton Edmund, Aviation Cadet, U.S.N.R.

Ursell, Charles Russell, II, B.S. in Ae.E.; Engineer, Western Div., Pan American Airways System.

Wagner, Edward Alois, Ae.E.; Asst. Aero. Engineer, Air Service Command.

Weaver, John Robert, Jr., B.M.E.; Draftsman, Grumman Aircraft Engineering Corp.

Whinery, David Gene, B.S. in M.E.; Aero. Engineer, Fleetwings, Inc.

Williams, Oswald, Jr., B.Ae.E.; Jr. Engineer, Republic Aviation Corp.

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